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REPORT ON THE

AGRICULTURAL EXPERIMENT STATIONS

1954

Agricultural Research Service
United States Department of Agriculture

ARS-23-1

April 1955

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The financial report on the operations of the agricultural experiment stations is required by law. The brief research summaries that follow represent a few examples of progress during the fiscal year 1953-54 in the comprehensive program of the agricultural experiment stations. These examples should not be regarded as a summary of all the research reported in the States. Details of the findings summarized here may be obtained by writing the director of the State experiment station in the respective States. The directors' names and addresses are given at the end of this report.

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1954
With Special Emphasis On
FOOD SCIENCE, TECHNOLOGY, AND MARKETING

By R. W. Trullinger, Assistant Administrator for Experiment Stations, Agricultural Research Service, in collaboration with the technical staff

FOOD SCIENCE, TECHNOLOGY, AND MARKETING

Scientific research at the State agricultural experiment stations and those in Alaska, Hawaii, and Puerto Rico contributes daily to the abundance of American life. That there is an abundance of food is reflected in the increase per capita food consumption of the Nation, even in the face of a 22 percent increase in population since 1940. Farm production of food and fiber has increased by 44 percent, however, since that time, resulting in an ample supply of food and feeds, and even in some cases in a surplus. This record rate of farm production, which now appears to be the rule and not the exception, may be attributed in large measure to the increased efficiency arising from better management practices derived from the agricultural research program.

Experiment station research has not been limited to seeking ways for improving production practices. It has been concerned, also, with the related problems of improving marketing and distribution of foods; with food processing, which plays an important part in the conservation of seasonal surpluses; and with preservation and utilization of food in the home.

Production, processing, marketing, and consumption are interrelated. Advances in any one area are often reflected in the problems that arise in another. Consumer demand for pork with less fat, for example, has spurred research for the production of leaner type hogs. This, in turn, has called for research to develop grades in which hogs of this market type are equitably represented. Again, feeding practices that produce soft fat in pork result in special problems to the processor in maintaining quality in frozen pork products.

Station researches have been well coordinated for effective integration of progress in these interrelated areas. Scientists of many skills--horticulturists, animal husbandmen, geneticists, entomologists, chemists, marketing specialists, food technologists, home economists, and others--have cooperated in effecting steady advances in food science, technology, and marketing.

Food science research has made vast contributions to our knowledge of the basic properties of foods; technological research has applied that knowledge to production and processing--aided by food engineering in the integration of science and technology; and marketing research has increased the efficiency of food distribution, reduced waste and quality deterioration in market channels, and helped in meeting consumer demands. The benefits of these advances are culminated in the use of food in the home. In this area, home economics research has aided in effective and economical utilization of the products of agricultural industry in the family fare.

A common goal of all these researches has been the improvement of food quality from farm to table. Quality means many things, and it may have a different meaning for the farmer than for the processor, the shipper, the retailer, the nutritionist, or the homemaker. Quality includes such attributes as color, size, ripeness, flavor, texture, soundness, and wholesomeness. Quality may mean such general attributes as adaptability for shipping, freezing, or cooking, disease resistance, or fleshing and finish. Quality may also mean nutritional value in terms of proteins, minerals, and vitamins.

Beginning on the farm, quality in foods is influenced by such factors as production practices, environmental conditions, and methods of handling the commodities preliminary to marketing. In processing, quality is influenced by process control and packaging methods. In marketing, it is affected by such factors as handling practices at shipping and intermediate points, packaging, storage conditions, and retail methods. Station researches have been concerned with all of these and other factors. In addition, methods of appraising food quality have been developed as an integral part of food research. They are the tools for measuring specific attributes and changes therein, and often provide the basis for grades and standards.

The brief highlights of research presented here testify to the contribution that State experiment station research has made to the progress of food science, technology, and marketing, for the benefit of the producer, distributor, processor, and consumer alike.

Food Production Practices and Food Quality

Color a guide to vitamin A value of sweetpotatoes

Sweetpotatoes may be an excellent or poor source of beta-carotene, provitamin A, depending primarily on the variety, a cooperative investigation by the Georgia, Louisiana, North Carolina, Oklahoma, South Carolina, Virginia and Virginia Truck stations shows. Of the 22 varieties or lines produced at 15 locations, those that were deep-salmon-fleshed were consistently high in this vitamin, whereas those that were white- or creamy-fleshed contained very little. The Allgold and Gold Rush varieties were outstandingly high in carotene. Both of the rather widely grown varieties, Unit I Porto Rico and Bunch Porto Rico, were below the average of the other varieties and lines tested. The three varieties ranking highest in ascorbic acid (vitamin C) content were Maryland Golden, Allgold, and Nancy Gold.

Baking qualities of sweetpotato varieties

In evaluating properties of present varieties of sweetpotatoes, investigators at the Louisiana station recommend baking as a performance factor in judging final quality. That baked sweetpotatoes reflect pronounced changes occurring within a variety and between varieties during storage is a fact often minimized by plant breeders in selecting seedlings for new varieties. The research shows that the amount of sugar accumulated in the sweetpotato during storage is not an indication of what could be expected in the cooked product. Also, that total solids content is directly related to the total sugar content after cooking in most varieties. This points out new factors to consider in sweetpotato breeding programs.

Raspberry varieties for freezing

Raspberry varieties differ in their suitability for freezing according to their chemical composition, a study by the New York State station shows. Varieties having higher ascorbic acid, soluble solids, free acid content, and lower pH values were rated "good" for preservation by freezing. Exceptions to this finding did exist, but, in general, the red raspberry varieties Willamette, Milton, Taylor, and Newburgh, the black variety Bristol, and the yellow variety Amber were found most adaptable for freezing.

Scab resistance in potato varieties

Basic research by the Colorado station has led to the discovery that chlorogenic acid is rather generally distributed in fruits and vegetables. It is present in potatoes, particularly just under the skin, where it apparently serves as a defense mechanism against injury. It was found that varieties resistant to scab produced high concentrations of chlorogenic acid under the skin of the tuber, whereas highly susceptible varieties failed to do so. This has made it possible to use a simple chemical test in the field to determine whether new potato varieties being developed are resistant or susceptible to scab. Great savings have thus accrued to the plant breeder and potato seed grower.

Potato sprouting checked by field spraying

Sprouting of potatoes in storage is controlled by field spraying the plants with a combination of maleic hydrazide and 2,4-D, the Colorado station reports. At the rate of 3 pounds of the diethanol amine salt of maleic hydrazide plus 1/2 pound of a salt of 2,4-D per acre, troublesome sprouting is eliminated in commercial storage. In the spring, a differential of $2.10 per 100-pound bag has been realized at the dock with potatoes field-sprayed by this treatment. The field spraying with 2,4-D, at the rate of 1/2 pound per acre, enhanced the red color of red-skinned potato varieties, without affecting interior quality or yields. These potatoes brought a premium of 25 cents per 100-pound bag in the Colorado growing area.

Apple quality affected by spray treatments

Extensive investigations by the Storrs station (Connecticut) and the Connecticut Agricultural Experiment Station (New Haven) have definitely established that the quality of apples is affected by spray treatments. That the physical appearance of the apple is affected by both insecticides and fungicides is exemplified by russetting found on Red Delicious apples sprayed with lead arsenate and by sun scald produced after applications of sulfur in hot weather. Color bleaching effects were found particularly noticeable with sulfur sprays. Chemical tests showed that both acid and sugar may be altered by sprays whereas the ascorbic acid content was not affected. Taste panels were frequently able to detect those insecticides having the greatest effect on the chemical and physical condition of the apples.

Lime and nitrogen effects on collards

Cooperative investigations by the Mississippi, North Carolina, and Virginia stations on the nutritional effect of fertilizer applications of lime and nitrogen on collards showed nitrogen applications to have more effect on the composition than lime. This effect was more pronounced in Mississippi than in the locations at the other two States. Lime increased the calcium content of the greens but had no other effect. Nitrogen increased the yield, ascorbic acid, carotene, phosphorus, nitrogen, and iron content of the collards.

Sunlight effect on ascorbic acid in tomatoes

In studying strains of tomatoes for ascorbic acid potentialities, the Illinois station found that comparisons were more accurate when fruits were sampled with regard to light exposure. Tomatoes from plants grown in sunshine were higher in ascorbic acid than those from shaded plants. Moreover, the uppermost fruits on the plant were the highest in ascorbic acid, since they were not shaded by the leaves. Fruits shaded for any length of time during the green stage did not reach the maximum possible content of ascorbic acid.

Environmental temperatures and fruit development

Correlations between temperature and deciduous fruit development from bloom to harvest are high, according to findings at the California station. For example, it was found possible from the temperature charts to predict harvest time for apricots with an accuracy of plus or minus three days, about 70 percent of the time. Prediction of the "reference date" for cling peaches, arbitrarily defined as a date 10 days after the pit began to harden, permitted the industry to adjust the crop through thinning at that time and to make early preparations for harvesting and processing.

Hormone treatments: Effect on meat

To determine whether any harmful effects may follow the consumption of meat from hormone-treated animals the Indiana station assayed meat from steers, lambs, and cockerels which had been treated with either stilbestrol or dienesterol. The amount of these residual estrogens did not exceed 0.1 microgram per gram of dried tissue of

animals slaughtered 28 to 140 days after treatment. The researchers point out that 22 pounds of meat would be required to furnish 1 milligram of stilbestrol per day, a normal therapeutic dose for man. The amount of residual estrogen apparently was not influenced by cooking, the kind of hormone used, or the implantation site in the live animal.

Beef quality improved by high feed level

The baby-beef stage of dairy cattle may be reached at an earlier age than is presently practiced, a study by the New York Cornell station shows. Holstein cattle fed at subnormal, normal, and supernormal nutrition levels were slaughtered at several ages and quality examinations were made of the meat. The muscle size, color of meat, iron, and vitamin B_{12} content were found increased with the increased level of feeding and with age. Meat from animals 48 weeks of age was preferred by judges rating palatability, indicating that this age might be best for slaughter.

Pork quality improved by restricted feeding

Animal production research indicates that restricting feed intake of growing hogs to favor muscle development without excessive fattening may provide a practical means of improving carcass quality. In tests at the Wisconsin station, pigs self-fed a ration containing only a medium level of total digestible nutrients (TDN) from weaning to normal slaughter weight yielded carcasses that were much leaner, firmer, and of higher grade than those from similar pigs receiving a high level of TDN. Similar studies at the Indiana and Missouri stations also show that limited feeding of corn under both dry lot and pasture conditions results in carcasses with a higher proportion of lean and less fat, compared with the normal practice of full feeding.

Breed and feed affect egg vitamins

The breed of the hen, and its feed, may influence the riboflavin and thiamine values of eggs, according to results obtained at the Montana station. The eggs of White Leghorn hens were found to be significantly richer in riboflavin than those from the New Hampshire breed and also richer in thiamine if fish solubles were added to the regular grain ration.

Restricted roughage reduces milk-fat content

Restricting roughage in the ration of the lactating cow may sharply reduce the fat content of the milk, according to the results obtained at the Wisconsin station. In a study of six cows, the milk-fat declined from an average of 4.62 percent on normal feeding to 2.14 percent on a daily ration consisting of 3 pounds of hay plus concentrates ad libitum. That fat metabolism was distorted was further evidenced by the decline in blood ketones.

Effects of bulk handling of milk on the farm

The bulk method of handling milk on the farm requires holding the milk for several days at temperatures of 40° F. or below. Investigators at the Wisconsin station found that this cool aging of raw milk decreases the susceptibility of the milk to rennet coagulation. The average increase in coagulation time of mixed night and morning milk held at 36° was 4 percent after holding for 1 day, 7.2 percent after 2 days, and 12.5 percent after 3 days. These findings may have significance for cheese manufacturing plants using such milk and employing rennet to set the curd.

Food Marketing in Relation to Consumer Quality

Precooling and icing improves sweet corn quality

In a North Central Regional marketing study, the Minnesota station has found that precooling and icing sweet corn before it leaves the farm will improve its retail quality. Excessive loss of sugars, moisture, and flavor of the corn was prevented for 3 days post-harvest by this low-cost treatment. Precooled and iced sweet corn was equally good

whether prepackaged or marketed in the husk. The prepackaged product, according to the Indiana station, cost more, but in high-income areas sales compared favorably with those of precooled bulk sweet corn. The Indiana station also found that using a cardboard master container with an ice pack in a polyethylene bag reduced certain shipping problems with iced, prepackaged corn. The container maintained low corn temperatures with a minimum of ice and reduced shipping space and costs. In another study involving eastern markets, the New Jersey station found that iced sweet corn packed in wet-strength paper bags on the farm and shipped to wholesale markets sold well in spite of its higher price, in competition with corn in other containers.

Controlled atmosphere for apple storage

Findings at the Maine station suggest that apples held in storage in the course of the marketing process may retain the fresh apple flavor for nearly a year if the storage atmosphere is controlled. By reducing the oxygen in the atmosphere from 20 to 2 or 3 percent and raising the carbon dioxide from 0.03 to 5 or 6 percent, the respiration rate of the apples was slowed down and the chemical and physical changes causing softening and discoloration were limited. A temperature of 38° C. was maintained because high concentrations of carbon dioxide may injure the fruit at low temperatures.

Grain damage in storage

At moisture contents of 13.5 to 14.5 percent, the Minnesota station found that wheat kernels were invaded by a slow-growing strain of mold, Aspergillus glaucus, which requires special techniques to detect. Once the seed is heavily attacked by storage molds, it is more susceptible to later deterioration than grain that is low in mold count. Results of the research emphasize the need for extensive sampling of commercial bulk storage of grain for moisture range fluctuation, and many commercial elevator firms plan to sample all of their larger bins at regular intervals.

Off-flavor in stored milk products

Certain dairy products, particularly butterfat and dry whole milk, are susceptible to the development of a coconut-like off-flavor upon storage. Evidence obtained at the Pennsylvania station indicates that lactones are responsible for this defect. The lactones apparently develop through intramolecular changes in the fatty acids of the butterfat. The mechanism of the reaction appears to be nonoxidative, hence vacuum-packing of the dry whole milk does not hinder the development of the off-flavor. Hydrogenation of milk fat or low temperature storage of products will effectively prevent the defect, whereas high temperature processing and storage at elevated temperatures aggravate it.

Effect of lighting on prepackaged beef

The quality of cut meats merchandized in the self-service market is subject to changes caused by lighting used in the display case, the Iowa station has found. According to measurements made, visible color changes occur in fresh packaged beef early in the storage life when ultra-violet light is used, whereas similar discoloration with the display under fluorescent light requires a longer time. Ultraviolet radiations also produced marked dehydration of cellophane-wrapped beef. Although the bacterial growth on the surface of the beef is reduced by ultraviolet light, from a practical standpoint the benefits are nullified by the accompanying color darkening and desiccation.

Raw and canned tomato grades related

Growers and processors have benefitted by research at the Ohio station (coop. USDA) which established the relationship between the grades of fresh tomatoes and processed products. Data obtained in the study showed a processor can expect to pack Grade A or Fancy tomatoes from 90 percent or better of U. S. No. 1 tomatoes and that Grade C or Standard tomatoes can be packed from Low U. S. No. 2 tomatoes. Higher grade products could not be obtained from the lower grades of raw stock because of poor color and low

drained weight. Selecting loads of raw tomatoes for each quality contemplated will result in a more uniform pack of known quality of canned tomatoes, the station concludes.

Maturity grades and market returns for canning peas

The market quality of canning peas in relation to returns to growers has been investigated at the New York State station. Growers receive top prices for peas marketed at the tender, immature stage, at which they grade between 80 and 85 on the Tenderometer scale. On the other hand, harvesting at this immature stage results in severe losses in yields and returns to the growers. As a basis for more equitable grading practices, a study was made of the processing quality of peas in relation to Tenderometer grades. It was found that peas a little more mature, grading as much as 20 points higher on the Tenderometer scale, would still make Grade A canned peas. At this maturity, the field yields were one-third greater than for the peas at Tenderometer grades 80 to 85. As a result, contract prices in 1953 averaged about $22 per ton higher in Tenderometer grades above 90, in which maturity ranges the yields were higher and the net returns substantially increased.

More effective cream grading

Farm-separated cream, collected at the buying point, was investigated at the Kentucky station. Results tentatively indicated that some flavor defects were associated with a high content of water-insoluble acid (WIA), which increased with age of the cream, especially after 4 days. As the fat content of the cream increased, the WIA value decreased. Types of micro-organisms were not related to WIA. These preliminary findings, if borne out by subsequent work, will be of direct value in outlining quality improvement programs for cream producers, and in setting up more effective cream-grading procedures at creameries and cream buying stations.

More accurate method for egg grading

The California station has developed an X-ray technique which determines the yolk position in intact eggs. In day-old eggs, yolk position was not highly correlated with albumen quality. As the eggs deteriorated, however, the amount of end-to-end migration of the yolks after rotating the egg through 180° was shown to be related to the variance in egg quality. Adaptation of this finding may provide a new technique for egg grading that will reflect the degree of albumen deterioration.

Food demand and consumers' buying habits

Research at the Michigan station is currently measuring the demand for food and consumer buying habits. A panel of 250 families reports in detail on their food purchases weekly. Hundreds of products are included. These questions and answers illustrate some early results: Is the demand for butter still falling? Yes, in 1952-53, about 10 percent a year. How much substitution is there between butter and margarine? A 1-percent rise in butter prices increases the quantity of margarine sold by 0.5 percent, but a 1-percent rise in margarine prices gives a 0.35-percent increase in butter sales. How much does temperature affect sales of ice cream for home use? A 5° rise in temperature results in about a 5-percent increase in sales. Is beef consumption more sensitive to price changes than pork consumption? No, a 10-percent change in prices results in a 15-percent change in purchases, in the opposite direction, for both. Are consumers more responsive to turkey prices at Thanksgiving or Christmas? They are more responsive at Christmas. How often do families buy apples during the year? The average family buys apples 12 of the 52 weeks.

Peaches: Consumer reaction to market quality

That 85 percent of consumers will purchase tree-ripe peaches when confronted with a choice between hard-mature and tree-ripe fruit marketed side-by-side at the same price was shown by a study by the West Virginia station. In a controlled experiment

carried out in 5 retail stores, tree-ripe peaches were displayed which had been harvested 2 to 3 days after they normally would have been picked as hard-mature peaches. The tree-ripe peaches were generally large, more uniform in size, and showed more orange color and less green than hard-mature peaches. Sales were consistently greater when tree-ripe fruit was offered. Total sales were more than doubled by either offering only tree-ripe or matched lots of tree-ripe and hard-mature peaches.

Food Processing

Film on cooker coils prevented

The coils of atmospheric cookers, used to evaporate tomato juice during processing, frequently become coated with a film of the juice and is known by the industry as "burn on." The Illinois station has found that the addition of the enzyme, polygalacturonase, to the tomato juice prevents the film deposition.

Fast freezing of poultry prevents discoloration

Each year the poultry industry loses thousands of dollars on chickens and poultry because of a reddish brown discoloration of their carcasses during freezing. Research at the New York (Cornell) station has revealed that fast freezing will prevent this discoloration. In the Cornell experiments, birds fast frozen at -20° in a blast of air were light in color. There was a gradual darkening of the flesh as the rate of freezing became slower. The method of plucking and of cooling preparatory to freezing was also important. Birds semi-scalded at 126° F. and cooled in a blast of cold air were the lightest in color, whereas those subscalded at 140° and cooled in refrigerated water were the darkest. For storage, it was found essential that the storage room be equipped either with freezing plates or a blower to circulate the air.

Deterioration in frozen ground pork

The Missouri station finds that ground pork obtained from animals with soft fat deteriorates more rapidly in frozen storage than meat from animals with firm fat. Feeds such as soybeans and peanuts produce soft pork which is subject to oxidative deterioration during freezer storage. Firmness of fat had no significant effect on the keeping quality of pork chops and roasts, however. Proper packaging in laminated paper offered protection against rancidity development and also prevented dehydration of the pork. The adverse effects of fluctuating temperatures were not as pronounced as the effects of long storage periods, which produced progressive deterioration, but storage at 0° F. or lower is recommended.

Factors affecting the preservation of cured pork

The need for immediate chilling and curing of pork carcasses following slaughter is emphasized by a study at the Arkansas station. A 4-hour delay in chilling affects the aroma and flavor of the lean pork. The effect was more pronounced with a sugar cure than a plain salt cure and shoulders were more affected than hams. After a 7-day delay in curing hams, a large bacterial growth on the skin developed, the shanks became somewhat slippery, and the fat was rancid.

Preventing losses in pickle stock

Enzymatic softening of commercially brined cucumbers causes a serious economic loss to the pickle industry each year. The North Carolina station (coop. USDA) has offered a new approach to this difficult problem, centering physical, chemical, and microbiological studies around the growing cucumber plant and fruit. The results of tests now appear to implicate molds on the plant, particularly on the flowers, as a potent source of the softening enzyme. Cucumber flowers with heavy mold populations remain attached to the cucumbers after harvest, and enzymes are thus introduced into the pickling brine. Further tests demonstrated that firm salt stock could be obtained by the removal of all blossoms

before brining and that softening could be artificially induced upon the addition of blossoms to cucumbers in the brine. Mold identification studies are continuing in an effort to characterize them with respect to their enzyme activity.

Improved process for sorghum sirup

In research to improve the flavor of sorgo sirup, amberlite resins have been used at the Mississippi station to remove the acids from the juice. This gives a sirup with a less sharp taste. Before the amberlite treatment, all suspended matter must be removed from the juice, either by heating or by adding lime, and then filtering.

Milling technology

By grinding hard red spring wheat into flour of six degrees of fineness, cereal workers at the North Dakota station found a definite relationship between protein content and size of flour particles. In making bread, the mixing quality of the dough and the volume of the loaf were directly related to protein content of the flour. During these milling and baking tests it was learned also that different wheat varieties grind to different degrees of particle size, and that even a greater variation came from wheats in different areas. Thus, it is possible for the miller to improve the baking quality of flour by judicious selection of wheats and blending of flour milled to varying degrees of fineness.

Preparation of calcium pectinates

In preparing low-methoxyl pectinates for use in gels, the Delaware station has discovered a method which employs a low-cost salt, instead of the usual large volumes of alcohol required for recovery of the pectinates. The process involves acid-extraction and demethylation treatment of apple pomace at controlled acidities, temperatures, and times, followed by the precipitation of the low-ester pectins with calcium chloride. The calcium-precipitated pectinates were higher in grade, although slightly lower in yield, than the alcohol-precipitated pectinates. Utilization of these pectinates in molded salads, desserts, jellies, medicines, and films has been practically applied.

Pectin from passion fruit

Investigation at the Hawaii station show that the rinds of passion fruit from which the pulp has been removed yield an excellent jellying pectin, comparable in quality to citrus pectins. In the recovery of pectin from the passion fruit rinds, inactivation of several pectic enzymes by steam blanching was necessary to stabilize the product. Pentose sugars, believed to contribute to the gel-firming properties of the pectin, were also present. Because of the distance of the Hawaiian Islands from the mainland, local use of the liquid pectin is feasible.

Canned blueberry mix for pies

A new and expanding market for blueberries has been realized by results of research at the Maine station. A blueberry piefilling, developed cooperatively with Maine processors, has been commercially produced in four canning plants in the State. Approximately 40,000 cases were canned during the 1953 season with indications that production of this product could be increased in 1954.

Canned fruit products

The Puerto Rico station has developed canning procedures particularly applicable to tropical fruits, abundant locally, but often largely wasted because seasonal production exceeds demand. With attention to choice of satisfactory varieties, processing problems due to characteristics peculiar to the fruits, and stability in storage, the station has developed very satisfactory canned mango, soursop, and guava nectars, guava shells, and improved guava jellies. A canned juice of remarkable keeping quality has also been prepared by blending grapefruit, orange, and pineapple juices. The pineapple juice pre-

vents the development of off-flavors which takes place in canned single-strength orange and grapefruit juices. As a result of this research the local government and private industry are taking the necessary steps for rapid expansion of the canning industry in Puerto Rico.

Frozen baking bananas

The cooking banana, often mistaken for eating bananas, freezes very well, the Hawaii station reports. Prebaking or preboiling adequately preserves this fruit's flavor and natural color during the period of storage. Conserving surplus ripe bananas by freezing may develop a new product, especially suited for the local market.

Orange concentrate as flavoring for ice cream

A formula for preparing an orange injection flavoring material for a variegated orange ice cream has been developed by the Florida station. A pectin stabilizer, sugar, and water are combined, given the necessary heat treatment, and cooled prior to the addition of the partially thawed citrus juice concentrate. Added when thawed only sufficiently to be emptied from the cans, the frozen orange concentrate provides the true fresh flavor of the fruit in the finished ice cream. Available at three fountains on the campus of the University of Florida, the product has been commanding about 10 percent of total ice cream sales since October 1, 1952.

New frozen juice concentrates

An important outlet for cherry and prune growers may develop as a result of research by the Oregon station. Frozen concentrates of Italian prunes and blended Royal Ann and Bing Sweet cherry juices have been developed in which the natural fruit flavors are retained. The juices were prepared by mashing fresh fruit and pits in a hammermill, adding sugar, and cooking for 20 minutes. High quality products were obtained by the addition of an enzyme which settled and separated fruit cells, allowing clear juice to be filtered. Work on raspberry and other berry juice concentrates is in progress.

Quality prepeeled potatoes

Recent reports have estimated that prepeeled potatoes are now being marketed at the rate of 2 million bushels annually. Institutional channels have been the main outlet for this product. The freshly peeled potatoes, susceptible to both enzymatic and microbiological deterioration, discolor under ordinary retail conditions. Results of trials by the Massachusetts station have demonstrated that briefly immersing the peeled potatoes in an aqueous solution of sodium bisulfite will postpone the onset of discoloration for about 20 days, provided the potatoes are stored at 40° F. or below.

New pecan product

A pecan butter for use in milkshakes, ice cream, and bakery and confectionery products, developed by the Georgia station, has high flavor and good keeping qualities. This product was prepared by dry roasting pecan meats at 365° F. for 16 minutes, grinding to a fine consistency before cooling, then adding 1 percent salt and 1-1/2 percent hydrogenated fat, then packing and sealing while warm.

New cheese

A new approach to cheese manufacture has been accomplished by investigators at the Minnesota and Wisconsin stations, with the production of a semisoft, mold-ripened white cheese. The unique step in its manufacture involves the use of white mutants of the mold Penicillium roqueforti as the cheese-ripening organism. These white molds are produced by irradiating the parent blue mold with ultraviolet light. The cheese made with the UW-12 mutant has a soft buttery body, excellent spreadability, blends well without stringiness in cooking, and has a relatively mild flavor in contrast to the crumbly body and

pronounced flavor of typical Blue cheese. Currently, one commercial plant is making acceptable mild-flavored cheese from pasteurized, homogenized milk inoculated with this mutant. The cheese is ready for the market in 90 to 120 days and consumer reaction has been favorable.

Other new cheeses include a family-size, rindless Swiss-type cheese made from pasteurized Grade A milk of 4 percent butterfat, developed by the Indiana station, and a low-fat soft spreadable cheese developed at the Ohio station from a milk-sweet cream-buttermilk mixture. Both of these cheeses have been marketed.

Venturi atomizer in spray drier design

The Minnesota station has developed a spray drier with a Venturi atomizer, which atomizes the condensed milk and at the same instant mixes the resulting spray with the drying air. Inlet air at the temperature of 535° F. has been used to produce dry whole milk having high solubility and no color defects. Use of this high inlet air temperature with a constant exit air temperature of 170° resulted in an increase of 35 percent in heat efficiency and more than doubled the powder production of the drier. The hot air was reduced from a velocity of 900 feet per second at the throat of the atomizer to 200 feet per second at the end of the diffuser. Efficient design of the diffuser was an important factor in reducing the power requirements of this drier, which were less per pound of water evaporated than that of most driers.

Production of melon-rind products mechanized

A custom-made feeding and cutting machine for use in the manufacture of watermelon rind products such as pickles, relish, and glace has been devised by the Georgia station. Unwanted parts of the cut fruit are "machined" away after the red meaty part has been scooped out by means of a rotary brush. The rinds are then subjected to the action of a motor-driven device which peels sectioned rinds and cuts them into small, uniform pieces in one operation. Mechanizing the major operations of processing the rinds reduces preparation costs and opens commercial possibilities for utilizing unharvested watermelons, estimated in 1951 at 50 percent by 144 Georgia growers, and also the byproduct rinds of the watermelon seed producing industry.

New retort speeds processing

An experimental cooker, designed by the Indiana station, offers possibility for shortening processing times of foods, improving their quality, and killing heat-resistant spores of food spoilage bacteria. It consists of a standard, horizontal pressure retort shell with an enclosed shaft-borne yoke and a can-bearing frame driven by an external motor. The movement of yoke and frame in the shell is both a free-spinning and rotating action, enabling the horizontal end-over-end movement of the can being processed. Turbulence is induced in the can, and the resulting agitation greatly speeds heat penetration. By the addition of rotation to end-over-end agitation, the number of headspace movements in the can are increased and further improvement of heat penetration over systems presently available is possible.

Methods for Evaluating Food Quality

Flavor evaluations by taste panel methods

The Maryland station has made use of an efficient measurement of the flavor, or degree of off-flavor, in foods. Known as the "multiple comparison" test, the method has been applied to evaluating flavor differences in new varieties and in detecting possible off-flavors in processed fruits and vegetables caused by insecticide and fungicide applications. It provides a ready means of ranking treatments used on food products, especially those which show marked variability.

Method for detection of pesticide residues

A new basic analytical method for detecting insecticidal residues in foodstuffs has been developed by the University of California Citrus Experiment Station. Microamounts of chlorides may be determined with accuracy and precision by this direct reading method which is sensitive to the chloride ion in concentrations from 0.02 to 10,000 p.p.m. Since approximately half of the insecticides now in commercial use contain organically bound chlorine, this method will find wide application in determining magnitudes and locales of persisting chloride residues in foodstuffs. Developed cooperatively with a leading manufacturer of scientific instruments, the method, involving only modest equipment, promises to find use in clinical and sea-water chemistry as well.

Camera aids cereal research

Photomicrography, especially motion pictures, has been utilized in cereal research by investigators at the Nebraska station. The method has been used to show and explain the differences in milling properties between hard and soft wheats, and the effects of tempering on milling properties. It has also been used to elucidate the changes involved in fermentation of doughs, the baking of bread, and the staling of bread. The motion photomicrographs have made visible many characteristics of starch that have been largely theoretical. Visual observation makes possible the presentation of these characteristics and their meaning to the starch industry, the milling industry, and the baking industry.

Index of meat quality

Tenderness in meat--or the converse, toughness--are important attributes in determining quality. To estimate these subjective qualities, the Ohio station has adapted techniques for chemically determining the amount of fibrous or connective tissue in meats. The method developed, which does not require preliminary separation of the fibrous tissue, consists essentially in determining the meat's content of hydroxyproline. This amino acid is present in uniquely high amounts in collagen and elastin, the chief components of connective tissue.

Home Food Preservation

Easy, safe, home vegetable canning

The cold pack method in home canning of blackeye peas, lima beans, carrots, and summer squash takes much less total time and work than the hotpack or raw pack-steam methods, research at the Texas station (coop. USDA) shows. In coldpack canning, raw vegetables are packed directly into the jars, which do not need to be sterilized previously, and boiling water is added until level with the top of the jar. After adjusting the lids, the jars are placed in a pressure canner, and the food is processed at 10 pounds pressure (240° F.). Safe processing times for both pint and quart jars have been determined.

Freezing and dehydrofreezing of garden vegetables

Many cool season crops grown at high elevations are superior in flavor and texture to the same crops grown in hotter, wetter climates, research at the Wyoming station shows. Varieties of broccoli, cauliflower, peas, and snap beans that thrive in these cool climates are adaptable to home freezing, and standardized blanching and freezing techniques have been developed. For rapid blanching, essential to quality retention, a specially designed small kettle was developed which permitted quick return of the blanching water to the boiling point. A home method developed for dehydrofreezing partially dried the vegetables before freezing and thereby reduced bulk to accommodate to limited home freezer capacity. This method was especially suited to snap beans, peas, and cauliflower.

Uncooked frozen jellies

Methods applicable for home preparation of uncooked frozen jellies which retain the natural fresh flavor of the fruit have been worked out by investigators at the Colorado

station. Excellent products can be made from frozen orange and grape concentrates. Other fruits that may be used include frozen sour cherries, raspberries, and strawberries. These jellies can be stored for a short time, two weeks or so, at ordinary refrigerator temperatures. For a longer time, they should be stored at 0° F., or lower.

Salt, used sparingly, improves frozen egg yolks

The gumminess in frozen egg yolks may be prevented if a small amount of salt, about 1 teaspoon per cup, is added to the yolks when preparing them for storage in a home freezer, the Wyoming station reports. Thick, viscous frozen yolks result, however, if too much salt is used, a study by the Indiana station shows. In their tests, employing from 1 to 5 percent salt, an increase in viscosity was noted with each addition of salt to egg yolks, whereas egg whites and a whole egg mixture were little affected. Other work, at the Alabama station, demonstrated that the rubber-like quality that develops when egg yolks are frozen whole may be largely prevented by placing the broken out yolks in a 20 percent salt solution for 20 minutes before freezing. The treated yolks, however, were not as liquid as the fresh, unfrozen ones.

Food Utilization and Management in the Home

Cooking methods for green soybeans

Using the soybean in the green bean stage is recommended by the Hawaii station because it adds variety and nutritive value to the native diet. Experiments showed, however, that care must be taken in cooking, lest large vitamin losses occur in this vegetable, long publicized as a good source of the B vitamins. Maximum vitamin values were retained by parboiling the beans 5 minutes to facilitate shelling, then cooking in a small amount of water until done, and utilizing the cooking water in serving. An alternative method that also resulted in good retention of the B vitamins was the use of a pressure saucepan when care was exercised not to overcook the beans.

High altitude cooking and canning

Three-fourths of the State of Wyoming has elevations of 5,000 feet or more. At these high altitudes, homemakers are faced with cooking, baking, and canning problems for which station home economists are providing answers. For example, recipe adjustments for quick breads and cakes include the use of larger amounts of liquids. Flour dries out in the dry climate, particularly if kept in a bin or stored in sacks, and alters the absorption of the liquid in the dough, the research shows. Temperatures below those recommended for sea level were found best for deep-fat frying. Canning studies have established the cooker pressures necessary at various altitude levels to give temperatures adequate for safe canning of different products. The Colorado station has been using a specially constructed, controlled altitude chamber to simulate elevations of 7,500 to 10,000 feet to study recipe adjustments for baked products.

Cake comparisons

The homemaker who must manage her time as well as money in preparing good meals, including desserts, will find some useful pointers from a study conducted at the Michigan station. Cakes, freshly mixed and baked, frozen cakes, and ones prepared from mixes, were rated as to palatability, cost, and time required for preparation. The findings indicate that homemade cakes in the freezer may be a convenience, but not a time-saver, if the homemaker counts the total time for mixing, baking, wrapping, and thawing. The time-saving cakes were made from mixes, either commercial or home-prepared, although with the latter, the homemaker must count the additional time for preparing the mix. Comparing the two types of mixes from the standpoint of cake palatability and cost, the home-prepared mix was better for yellow cakes, the commercial mix better for white cakes.

Food-freezer plan

The food-freezer plan, currently popular in many sections of the country, offers more convenience than economy, the Massachusetts station reports. An investigation showed that purchasing frozen food by the plan resulted in little or no saving when compared with retail store prices. In addition, package sizes were not economical for all families. The amounts of juices, fish, meat, and poultry supplied by the plan were nutritionally adequate, but the fruits and vegetables supplied were nutritionally low for the period covered.

Foods and Human Nutrition

Ascorbic acid: Foods vs. synthetic vitamin

Ascorbic acid from tomato juice, green beans, lima beans, brussels sprouts, and orange juice is utilized as well by the body as an equivalent amount of the synthetic vitamin. This finding was revealed in an investigation at the Pennsylvania station to determine how human subjects respond to different intakes of ascorbic acid. Blood plasma levels of ascorbic acid reflected a carryover effect of previous low or high intakes of the vitamin, an indication that individuals with a previous low intake of ascorbic acid cannot hope to attain, in a short time, adequate nutrition with respect to the vitamin, with average intakes.

Folic acid in Puerto Rico rural diets

Folic acid is a vitamin that occurs in foods in a variety of forms, and is known to produce favorable blood response in certain types of anemia. Research at the Puerto Rico station showed that the basic diet in common use in rural areas was low in folic acid--a finding of local medical importance. The high folic acid content of cooked dry legumes indicated the value of these popular foods in supplying the little folic acid present in the rural diet. Among the fruits eaten locally, avocados ranked highest in the vitamin. The dry food yeast Torula utilis was found to be very rich in folic acid, suggesting its value as a regular supplement to the Puerto Rican rural diet. Such use would have economic as well as nutritional significance to Puerto Rico, and other Caribbean islands, where the yeast is commercially produced.

Milk improves utilization of carotene

Research at the Arizona station showed that milk in the diet improves the utilization of carotene, which is converted to vitamin A in the body. Rats fed carotene homogenized in skim milk had greater storage of vitamin A in their livers than rats fed the carotene emulsified in water.

In nutrition experiments with rats and human subjects at the Louisiana station, the utilization of dietary carotene was found to be influenced by the kind and quantity of protein in the diet. The need for dietary protein of good quality to assure the best use of food carotene is particularly significant because carotene supplies about two-thirds of the vitamin A value of the average human diet in the United States.

Restricted diets need careful planning

Milk, wheat, and eggs are frequent causes of allergic reactions, necessitating elimination of these foods from the diet. The nutritional adequacy of diets thus restricted, but otherwise composed of common foods, was studied at the Tennessee station. Young college girls served as subjects in the metabolism experiments. It was found that appropriate supplements of dicalcium phosphate and riboflavin improved the diets so that the nutritional needs of the subjects for calcium, phosphorus, riboflavin, and nitrogen were met. The results indicated, however, that calcium was more readily available from milk than from the mineral supplement, and that careful planning was required to make the restricted diets nutritionally adequate.

Effect of amino acid imbalance

The importance of the quality as well as the amount of protein in the diet has been pointed up by experiments at the Alabama station. Fatty livers were produced in rats fed a variety of diets which did not contain enough protein, or the right kind of protein, to supply the necessary balance of amino acids. Fat infiltration of the livers was prevented, however, by proper supplementation of the diets with pure amino acids. Threonine, lysine, methionine, and several additional amino acids were involved in the prevention of fatty livers.

FRUIT PRODUCTION

Nutritional needs of fruit trees

Leaf analysis proved so accurate as an index to the fertility status and needs of fruit tees that the Michigan station established a "Grower Service" for leaf analysis for various economic fruits. A survey of leaves collected from 63 vineyards revealed several instances of potassium deficiency sufficient to reduce yields, even before deficiency symptoms were outwardly visible in the leaves.

Observation on peach leaves changed the diagnosis in one orchard from virus trouble to potassium deficiency and located an area of extremely low phosphorus nutrition. Several other State stations and the Department have also found leaf analysis to be an important and rapid method for determining nutrient status in orchards and thereby aiding the grower in more effective production methods.

A leaf-analysis survey conducted by the Massachusetts station in 30 McIntosh apple orchards revealed magnesium to be the element most frequently in low supply. Nearly half of the trees examined fell below the desirable magnesium level. Nitrogen, often considered to be the most frequent limiting element in orchards, was found below the desirable point in only 30 percent of the trees. Phosphorus level was generally sufficient.

Broader spread for apple trees

Broader spread of the limbs of young Red Declicious apple trees was obtained by the Idaho station by the simple expedient of leaving all growth on the trunk between the main scaffold limbs and cutting this growth back severely each winter instead of removing it entirely, as is the usual practice. The spread of the young tree was increased as much as 86 percent and crotch angles by as much as 29 percent. This increased spread is said to be of particular value in varieties such as Red Delicious, which tend to develop a narrow upright tree with narrow branch angles.

Compatibility in pollination

Frequent failure of Red Delicious apple to set satisfactory crops when other varieties growing in the same area produce yields was attributed in part, by the Ohio station, to the relatively long period between pollination and fertilization of the Delicious embryos. The practical suggestion is offered that the grower provide plentiful bees for pollination and interplant Delicious with compatible pollen varieties. The trees should be maintained in vigorous condition by adequate fertility, pruning, and spraying in order that condition of the tree may not become a limiting factor.

Aluminum protectors for tree trunks

Aluminum foil wrapped around trunks of apple, sour cherry, and plum trees was shown by the New Hampshire station to serve as a practical cover for open wounds caused by winter injury. Later examination showed all protected wounds on all species to be greatly reduced in size or healed completely. Without wrapping, wounds were

nearly of their original size. The evidence favored the wrapping of tree trunks as a means of preventing injury to fruit trees located in exposed situations. Normal trunks wrapped continuously for three years had larger lenticels, but were uninjured.

New rootstock for semidwarfs

Seeking an apple rootstock that would produce semidwarf orchard trees and at the same time could be readily propagated by seed, the Pennsylvania station tested a number of apomictic Asiatic crabapples and found that Malus sikkimensis was outstanding in nursery performance and in compatibility with varieties grafted upon the stocks. Orchard tests are under way to gain information as to the longtime performance of the trees.

Retarding drop and decay

Maleic hydrazide, according to the Maine station, is as effective as naphthaleneacetic acid (NAA) and 2,4,5-trichlorophenoxylpropionic acid (TCPPA) in preventing preharvest drop of apples and at the same time has no unfavorable effect on the keeping quality of the harvested fruits. Excessive applications of borax to McIntosh apple trees resulted in the early appearance of brown core in the stored apples. High nitrogen treatments of the soil tended to decrease the keeping quality of the stored fruit.

Chemical thinning experiments

Of several materials tested by the Michigan station for the thinning of peach fruits, maleic hydrazide proved most promising. Over three seasons, when used in concentrations of 500 p.p.m. or above, maleic hydrazide reduced the set of peaches to a material extent. There was some indication of varietal difference in response to maleic hydrazide and need of taking into consideration vigor, stage of bloom, etc., of the trees under treatment.

Time of application of fruit-thinning sprays to apple trees was found of major significance by the Missouri station. In the experiment, NAA sprays were applied to heavily blooming Winesap trees at 5-day intervals from 5 to 30 days after full bloom. The maximum thinning was accomplished by the 15-day application, but was decreased thereafter until the 30-day treatment was little different from the control nonsprayed trees.

As reported by the Michigan station, Halehaven and Elberta peaches were successfully thinned when CIPC (isopropyl-N-(3-chlorophenyl) carbamate) was applied at concentrations of 300 and 400 p.p.m., using a high-pressure hydraulic sprayer. Equally good thinning was obtained when Rochester and Redhaven peaches were treated with CIPC applied at concentrations of 400 and 500 p.p.m., using an airblast-type sprayer.

Naphthalene acetamide (NA Amide) sprays were found by the Maryland station to be effective in the thinning of apple fruits and, in proper concentration, caused no foliage injury such as resulted from the use of NAA. In general, the later timing of the sprays, up to 18 days after full bloom, produced more thinning than did earlier applications. Trees thinned effectively with NA Amide sprays in 1953 bloomed heavily in 1954, whereas treated control trees carried insufficient bloom to produce a partial crop. There were differences in varietal response, with Transparent, Duchess, Wealthy, Jonathan, Stayman, and McIntosh reacting favorably. More than an estimated one-third of the apple acreage in Maryland was thinned chemically in 1954.

Seedless pears

The capacity of the Bartlett pear to set commercial crops of fruit without pollination under favorable conditions was noted by the California station and offers an explanation of the contradictory reports regarding self-fruitfulness in this important pear variety. A study of Bartlett pear orchards in 12 California counties showed that trees in solid blocks, or with only a few pollinizers, produce a large proportion of seedless fruit. The seedless pears were found, on the average, to have a more desirable and uniform shape than those containing seed.

Raspberry mulching

Latham red raspberries under mulch outyielded cultivated plants by 15 percent according to records obtained by the Ohio station. The berries on the mulched plants were 7 percent larger, which would make them easier to harvest and more attractive to the purchaser.

New fruit varieties

The New Jersey station distributed two new varieties of peaches during the year, named Sunrise and Blake. Sunrise is the earliest ripening, yellow-fleshed peach bred at the station; and Blake, named in honor of the late Professor M. A. Blake, former head of the horticultural division, is an attractive, yellow-fleshed variety ripening a week or so before Elberta.

Four new plums, Laroda, Red Roy, Queen Ann, and Nubiana, were released by the California station in 1954 as contributions to the important plum-producing industry of the State.

Four new pears, Dabney, Ayers, Mooers, and Hoskins, products of the long-time breeding program of the Tennessee station conducted in search of blight-resistant pears with good horticultural qualities, should make possible successful pear production in an area where the usual horticultural varieties succumb readily to fire blight.

Hayes and Patrick are the names given by the Oklahoma station to two desirable new pecans discovered in a broad survey of potentially valuable native trees.

Characterized by clusters of 10 or more large attractive bronze-colored berries, Gascup, a new muscadine grape originated by the Georgia station, is scheduled for release in November 1954. The new grape is promising as an addition to the home garden and for roadside marketing.

A new seedless grape, jet black in color at full maturity and similar to the well-known Thompson Seedless in shape and size, was released by the California station under the name of Beauty Seedless. Commercial shipments to New York markets indicated that the new grape carries well, and since it is earlier in maturity than Thompson Seedless, it should prove a valuable variety for early marketing.

A new red raspberry was released by the Washington station under the name of Puyallup. Because of its high merit for commercial freezing and canning and good shipping quality, it promises to become an important commercial variety in the fruit area of western Washington.

Purple Autumn raspberry, developed and released by the Illinois station, bears two crops of fruits each year. The berries are purple in color, conic in shape, and high in flavor, and should prove to be a highly acceptable addition to the home fruit garden.

Named in honor of two famous horticulturists, Dr. L. H. Bailey of Cornell and Dr. U. P. Hedrick of Geneva, Bailey and Hedrick blackberries were developed from the New York State station fruit-breeding program. Plants of both varieties are vigorous and productive, and the fruit are large, attractive, and of good quality. Bailey ripens a few days earlier than Hedrick thereby prolonging the season of desirable small fruits.

The Croatan blueberry, a product of the cooperative breeding project of the North Carolina station and the Department, possesses desirable horticultural characters such as good size, color, and flavor. In addition it possesses resistance to canker, a serious menace to blueberry culture in North Carolina and adjacent areas. Croatan is recommended as a productive, second-early variety for eastern North Carolina, but it will not grow farther north.

Dixieland strawberry, originated by the North Carolina station and the Department, is considered of merit as an early berry for southern States. Ripening season is similar to Blakemore, but Dixieland greatly outyielded the older variety in 1952 and 1953. It is considered promising as a companion variety to the later maturing Albritton.

VEGETABLE CROPS

Culture of Vegetable Crops

Supplementary irrigation

Maintaining the soil moisture through supplementary irrigation increased yields of beans up to 4,175 pounds per acre at the Arkansas station. At the Missouri station marketable yields of Rutgers tomatoes were increased from 3.2 tons per acre on the unirrigated plots to 15 tons per acre for the plots having 75 percent of available moisture. At the Tennessee station, maximum yields of beans were secured when 3 inches of water a week were made available; however, the most economical yields were secured with 2 inches, and the best yields of turnip greens were produced with 2 inches of water. At the Mississippi station irrigation alone for the last 3 years has increased sweet corn yields 1-1/2 to 2 times that for nonirrigated sweet corn. When irrigation is used, the plant population can be increased from 16,000 up to 24,000 plants per acre.

Varieties vary in water requirements

Differences in water requirements between lima bean varieties were observed at the Utah station. Utah 16 lima beans did not require as much water as Clarksbush, they also matured 6 days earlier and had an increased yield of 660 pounds when shelled. The station also reports that the application of nitrogen and additional water brought higher yields of lettuce seed.

Fertilizer needs and limitations

Reduced growth of lettuce in the greenhouse following tomatoes at the Missouri station was closely associated with fluctuations in the available soil nitrates. At the Storrs station (Connecticut) boron toxicity appeared on snapbeans in spring and fall crops when 20 pounds or more of borax per acre were applied; however, there was no significant decrease in yield until the 80-pound borax rate was reached.

The Indiana station confirmed previous reports that phosphorous is the principal element needed in tomato transplanting solutions and found that monoammonium phosphate is excellent for this purpose. The tomato plants did not respond to either nitrogen or potassium in the mixture.

The Maryland station found that a combination of magnesium sulfate, borax, and a fungicide made the best foliar spray for tomatoes. The most effective time of application was shown to be when the crown-set-fruit began to color and again during the week of the third harvest. The resulting increase in yield was found to be entirely in No. 1 grade fruit. The processed tomatoes showed a firmness similar to that of tomatoes that had benefitted from the application of chelated calcium. The Kentucky station boosted early tomato yield with a combination of dextrose and hormone sprays applied to the foliage of the plants previously well fed with fertilizer applied in the soil.

Spacing plants for greater yield

Experiment stations have shown in recent years that much can be learned about spacing distances in order to get most desirable growth and highest yield. "Double" row planting of cantaloups at the Arizona station brought a big increase because the new practice allowed efficient use of land and irrigation water. Southern peas spaced 1 foot apart in the drill in 42-inch rows brought better yields at the Mississippi station than

spacings of 2, 3, or 4 feet. Peas seeded 1 inch apart in rows 6 inches apart yielded the greatest total number of pods and peas at the Iowa station, but the greatest number of peas per pod and number of pods per plant was obtained where the number of peas seeded was halved, i.e. seeded every other inch in rows 6 inches wide. At the Washington station the total weight of shelled peas produced was about the same in plots where row widths and seed spacings were 16 x 2, 8 x 2, and 4 x 4 inches.

Time and depth of plantings

Under New Jersey conditions temperatures experienced during ear development in sweet corn do not affect the quality as measured by sugar content and tenderness, the experiment station learned in an effort to determine the effect of different times of planting on kernel development. The Hawaii station found that the conically shaped heads which "Kaala," a new variety of lettuce, developed on some farms was caused by transplanting the lettuce too deeply. This practice also increased cracking of the midribs and reduced yields. In 23 treatments of asparagus, mounding rows 6 inches high proved best at the Delaware station.

Chemical control of flowering

The Michigan station has obtained some phenomenal success with a chemical growth regulator known as maleic hydrazide. This year the station reports the use of maleic hydrazide for specific control of seedstalk development in celery. Spray concentrations of 50 to 100 p.p.m. were used prior to an artificial cold treatment when the young plants had from 8 to 10 true leaves. The Michigan scientists also retarded development of seedstalk with higher concentration of maleic hydrazide at later stages of growth. In the case of acorn squash, maleic hydrazide induced considerable suppression of staminate flowerbud.

Quality in Vegetable Crops

Prolonging storage life with chemicals

The storage life of butternut squashes was improved at the Massachusetts station by spraying the vines with maleic hydrazide 3 weeks before harvest. Missouri station research established that hormone-treated tomato fruit tended to become softer than untreated fruit and was more subject to breakdown during distribution. This problem was, however, overcome by spraying N-Meta tolyl phthalmic acid on the whole plant. This chemical did not change the foliage in any way or soften the fruit, but it did stimulate fruit set and development almost as much as did P-chlorophenoxyacetic acid using as a cluster spray.

Handling late-season green tomatoes

Late-season tomatoes intended for mature-green harvesting require different treatment while in transit than do early-season tomatoes, the California station learned. In a study which related the effect of late-season cool night temperatures on fruit development to post-picking behavior and quality under typical transit conditions, the station found a number of important differences. For instance, late-season fruits were more susceptible to chilling in transit than were the early-season fruits. These findings have made it possible to improve the quality of late-season mature green picked tomatoes reaching today's markets.

High vitamin A tomatoes

The Indiana station has produced tomato strains containing about twenty times the normal concentration of beta-carotene or provitamin A. In these strains beta-carotene (an orange pigment) is produced largely at the expense of the red pigment found in normal garden tomatoes. Because of this fact, these strains produce orange-colored fruit. They should not be confused, however, with orange-tinted garden types now available. The latter contain other related carotene pigments which are no more vitamin active than

are normal red tomatoes. Studies of the chemistry and mode of inheritance of the carotene pigments in these special vitamin strains have demonstrated that four true-breeding types, each containing a different level of provitamin A, are possible. The highest level possible produces tomatoes with a vitamin A potency comparable to carrots, well known to be one of the best sources of vitamin A in the diet.

Infrared curing of onions

Research at the Texas station (coop. USDA) had shown that prestorage artificial curing treatments of onions using infrared (9 minutes) and forced draft gas fired dehydration (118° F. 4 hours) effectively reduced the incidence of neck-rot disease in both common and refrigerated storage (33° relative humidity 75 percent) during a 20-week storage period. The results obtained indicate that the artificial curing treatments employed, particularly the more rapid infrared treatment, will be useful as a pretransit and prestorage treatment to reduce losses from decay in transit and storage.

ORNAMENTAL PLANTS

Varying flower yields with light

Over 3 seasons the Oklahoma station has compiled information on how flowers react to supplemental light. Greenhouse-grown China-asters of commercially acceptable quality were readily produced for May and June sales by successive sowings from January through early March when the plants received at least 8 weeks of supplemental lighting applied from 5 P.M. to 10 P.M. nightly. The Massachusetts station found that carnation plants transferred from 50° to 60° F. following a day of high light intensity had less splitting and higher quality as determined by weight and stem length, than those plants kept continuously at 50°.

Fertilizer needs of flowers

Azaleas grown in peatmoss have a greater requirement for phosphorus and potassium than when grown in a soil mixture the Maryland station reports. In other nutrition studies it was found that greenhouse-grown hydrangea plants during the summer growing period need some phosphorus and potassium, but not necessarily a large amount in relation to the amount of nitrogen applied.

Improving greenhouse rose yields

Although the plants may show no noticeable symptoms, yields of greenhouse roses may be drastically reduced by failing to supply enough manganese, copper, zinc, or molybdenum, the New Jersey station learned. Foliar analysis served as a statisfactory method for evaluating manganese supplies in rose plants. The Iowa station, after studying the effects of soil mulches on greenhouse roses, found no marked soil changes in water requirements, pH, or available nutrients. The superiority of production in the mulched plots was associated with a high available water-holding capacity, low CO_2 content in the soil bases, and less extreme soil temperatures.

Wrapping carnation cuttings

The Massachusetts station obtained good results in packaging rooted carnation cuttings in polyethylene for periods up to 6 months and unrooted cuttings up to 4 months. Direct benching of carnation cuttings made possible with storage has reduced planting costs approximately one-half through savings in labor costs.

ESSENTIAL OIL CROPS

June clip improves peppermint

Menthofuran is an undesirable component of the peppermint plant which affects the quality of peppermint oil extract. According to the Washington station the content varied

New vegetable varieties

Crop	Variety	Station and cooperation	Type	Characteristics	Resistance to crop pests
Asparagus-----	3-9----------	Minnesota----		Used as pollen parent, produces progenies of high yield and spear diameter.	
Bean----------	Scarlet------ Beauty	New Hampshire	Shell (bush)	Bush, highly red-colored seed.	
	Idaho Bountiful	Idaho--------	Snap---------	Bush, flat-podded----------	Resistant to curly top virus.
	Golden Gem---	Idaho--------	Snap---------	Bush, round-podded, wax--------	Resistant to curly top virus.
	Columbia-----	Oregon------- USDA	Snap---------	Stringless Blue Lake pole, high yielder.	Resistant to curly top virus.
	Criolla------	Puerto Rico--	Snap---------	Low fiber, high yielding, withstands hot weather, similar to Bonita.	Resistant to rust.
	Seminole-----	Florida------	Snap---------	Bush, round pod, smooth--------	Resistant to strains of rust, mildew, and common bean mosaic virus.
	Monroe-------	New York (Cornell)	Dry----------	Pea bean type; earlier, larger seeded and higher yielding than Michelite.	Resistant to both strains of common bean mosaic virus.
Cauliflower---	Pau Kea------	Hawaii-------		Resistant to hot weather, selection out of Indian type.	
Cucumber------	Faribo Hybrid D	Minnesota----	Slicer-------	Vigorous, fruits 8-10 inches long, very smooth, small seed cavity.	
	Ohio MR 25---	Ohio---------	Pickling-----	Good for home garden----------	Highly tolerant to mosaic.
	Wisconsin SMR 12	Wisconsin----	Pickling-----	Color and shape of pickles not quite as good as SR6.	Resistant to scab and mosaic.

Lima bean-----	Mackie Lima--	California--	Dry---------	Standard type, adapted to hot interior valleys of California.	
Lettuce-------	Anuenue------	Hawaii------	Head--------	Ability to form heads in the summer, practically immune to tipburn.	
Muskmelon-----	Minnesota Honey	Minnesota---		Thick orange flesh, small seed cavity, sweet mild flavor.	Resistant to fusarium wilt.
	Pennsweet----	Pennsylvania		Early maturing, All-American Bronze Medal award.	
Onion---------	Fiesta-------	Idaho------- USDA Iowa	Sweet Spanish	F_1 hybrid, 20 to 30 percent more total solids, good keeper, good yielder.	
	Abundance----	USDA-------- Iowa Idaho	Yellow Globe	F_1 hybrid, long-day exceptionally high yielding storage type.	
	Eclipse------	USDA-------- Texas	Crystal Wax-	F_1 hybrid, less subject to bolting and splitting, very productive. Mild in flavor and bulk, a very attractive white.	Highly resistant to pink root.
	Encore-------	USDA-------- Iowa Idaho	Yellow Globe	F_1 hybrid, long-day type for limited storage, good yielder, high globe shape, soft flesh, and dark yellow scales.	
	Aristocrat---	USDA-------- Ohio Idaho Iowa	Yellow Globe	High globe shape, firm flesh, yellow scales which adhere well throughout long storage period.	
	Bonanza------	Idaho------- USDA Iowa	Yellow Globe	F_1 hybrid, long-day, storage-type, high globe shape, firm flesh, yellow scales adhere well throughout long storage.	
	Champion-----	USDA, New York (Cornell) Iowa Idaho	Yellow Globe	F_1 hybrid, long-day storage-type, heavy yielding, keeping quality roughly equal to early yellow globe, high globe shape, soft flesh, and scales do not adhere.	

New vegetable varieties--Continued

Crop	Variety	Station and cooperation	Type	Characteristics	Resistance to crop pests
Onion (Con.)	Contender----	USDA-------- Iowa Idaho	Yellow Globe	F_1 hybrid, long-day type, high yielding, high globe, soft flesh, light yellow scales only, fairly retentive-not for late storage.	
	Elite--------	USDA-------- Indiana Idaho Iowa	Yellow Globe	F_1 hybrid, long-day storage-type, high globe shape, fairly firm flesh, yellow scales adhere fairly well.	
	Epoch--------	USDA-------- Idaho Iowa	Yellow Globe	F_1 hybrid, long-day storage-type, high globe shape, firm flesh, dark yellow scales adhere well in storage.	
	Surprise-----	USDA-------- Idaho Iowa	Yellow Globe	F_1 hybrid, long-day storage-type, high yielding, high globe shape, firm flesh, yellow scales adhere well in storage.	
	Pioneer------	USDA-------- Colorado Idaho	Yellow Globe	F_1 hybrid, long-day storage-type, globe shape, firm flesh, dark yellow scales adhere well in storage.	
Pepper--------	Carolina Hot-	South Carolina	Hot---------	High yield of dry pepper, excellent color, uniform ripening.	High resistance to root-knot nematodes.
	Wisconsin Lakes	Wisconsin---	Green-------	Resembles Calwonder. Medium-sized fruits with thick red flesh, early maturing.	
Pumpkin-------	Cangold------	Iowa--------	Canning-----	Selection of Kentucky Field, oblong-shaped fruits 9 to 15 pounds, 2 to 3 inches thick, deep yellow flesh. Vigorous semivine.	

Southern Pea--	Louisiana Purchase	Louisiana---	Shell-------	Semivining, upright plant. Seed pods borne on long fibrous stiff peduncles indicating ease of hand or mechanical harvest; matures 3 to 4 days later than Early Blackeye.	Field resistance to leaf spot diseases and fusarium wilt.
Squash--------	Orange Banana	California--	Banana------	Selection of Pink Banana with bright orange-colored skin. Small seed cavity, prolific, has tough rind so is not suited for processing.	
Sweet corn----	Iosquaw------	Iowa--------	Golden------	Equal to Iochief in yield, has white interior silks, cross between Inbred 453 and Inbred 5145, Inbred lines 5146 and 453.	Slightly more susceptible to Stewart's disease than Iochief.
	Inbred 6038	Iowa--------	Golden------	Similar to P. 39 except tillerless and has white interior silks.	Fair resistance to Stewart's disease and helminthosporium.
	Inbred 5145	Iowa--------	Golden------	Can be used with Inbred 453----	Moderately resistant to Stewart's disease.
Tomato--------	Indark-------	Arkansas----		Fruits larger than Fortune or Rutgers, round meaty, ripens from the inside to a rich red color and is relatively free of cracking.	Strongly resistant to fusarium wilt.
	Red Top------	New York (Geneva)	Paste-------	Maintains deep red color and high solids content throughout the season, little cracking. Useful for blending late in season in improving color and consistency of juice, puree, and ketchup.	
	Manalee------	Florida-----	Green wrap--	Superior in yield and earliness to Grothen's Globe and wilt-resistant Grothen's Globe, more sensitive to nutritional deficiencies than Manalucie.	Resistant to catfacing, fusarium wilt, gray leaf spot, early blight, and leafmold.

New vegetable varieties--Continued

Crop	Variety	Station and cooperation	Type	Characteristics	Resistance to crop pests
Tomato (Con.)	W-R Brookston	Ohio--------	Canning, home garden	Withstands drought, good quality.	Resistant to fusarium wilt.
	Red Pickler	New Hampshire	Pear--------	Early, productive, determinate, single harvest.	
	State Fair	South Dakota	Hybrid------	Formerly known as hybrid 652 for home garden and green wrap.	
	Washington Forcing	Washington--	Greenhouse--	Good color, uniform medium-large fruit.	

fivefold in 31 different oil samples tested. Blossoms are known to be high in menthofuran, so by experimentation with the use of a mower to clip the heads of peppermint plants in mid-June a considerably lowered menthofuran content resulted.

Indiana mint studies

Cultural studies in mint growing at the Indiana station brought out the desirability of three weeder tillage treatments. These gave the highest oil yields compared with fewer treatments. The station also learned that peppermint plants require days at least 16 hours long for flower development, maximum growth, oil gland formation, and oil synthesis.

Wilt-resistant spearmint varieties

A spearmint plant resistant to both verticillium wilt and rust may be possible from crosses made by the Indiana station between the commonly grown, rust-susceptible Scotch variety of spearmint and a wilt-resistant type. The Michigan station also reports progress with verticillium wilt resistant mint seedlings that have been developed to the oil quality testing stage.

FIELD CROPS

Advances in crop breeding methods

Several new breeding methods promise further advances in crop improvement. Male sterility (lack of pollen in the flower) has been used in hybridizing corn (to eliminate hand-detasseling) as well as onions, castor beans, and other crops. Development of fertility-restoring seed stocks by the Texas and other stations is a further advance in production of corn hybrids by the detasseling-free method. When the male-sterile stock is used as the seed parent and a fertility-restoring stock as the pollinator, detasseling is obviated yet ample pollen for seed set is produced by the double cross hybrids.

Cytoplasmic male-sterility was found in milo (sorghum) by the Texas station (coop. USDA) and was bred into kafir varieties. Male-sterile Combine 60 crossed with other varieties gave rise to sorghum hybrids producing 25 to 30 percent above standard varieties. The Kansas, Nebraska, and Oklahoma stations also have found male-sterile sorghums and are appraising hybrid crosses.

Using colchicine to include genetic changes, the South Dakota station has produced sorghums with seeds as large as peas, larger heads, earlier maturity, shorter stalks, and quicker sprouting. Colchicine is thus an additional useful tool for the breeders for producing new variations and immediate fixation of these variations in pure lines and crosses. Other new and promising techniques are being used in the further improvement of barley, cotton, sugar beets, tobacco, alfalfa, and sweetclover.

Field crops in the South respond to irrigation

Supplemental irrigation of field crops in Southern States has resulted in higher yields and often better quality of product. The South Carolina station gained substantial and profitable increases of seed cotton with concurrent increase in staple length and oil content of seed. Cotton, corn, and sweetpotatoes have made noteworthy increases in yield and quality in Arkansas station experiments. Irrigation of flue-cured tobacco by the Florida station increased fertilizer efficiency and resulted in higher yields and better quality. The North Carolina station determined that the average net value increase of flue-cured tobacco with regular fertilizer and plant population was $147.24 per acre, attributable to 5.9 inches of irrigation per season to supplement rainfall. Supplemental irrigation by the Georgia station (coop. USDA) has increased corn and cotton yields, prolonged grazing periods on pasture, and has resulted in weight gains of livestock over nonirrigated land.

Adaptation of corn hybrids

Efficient corn production is largely the result of use of best available hybrids and good farm management, according to Pennsylvania station corn performance studies. Hybrids appear to differ in water requirements as well as in reaction to disease and insects. Those with relatively low water requirements may respond better to population-fertilizer increases than hybrids with higher water requirements when available moisture becomes limiting. Hybrids with lower-than-average water requirements may be more tolerant to biotic factors, particularly those that impair translocation. Hybrids with higher-than-average water requirements and above-average susceptibility to biotic factors present the greatest environmental risks.

Bird-resistant corn hybrids

Bird-resistant hybrids developed by the Ohio station (coop. USDA) and under field test, have sustained much less damage from starlings, grackles, red-winged blackbirds, and other birds. The barriers to bird attack are the long durable husks which are difficult for birds to remove. Mass feeding habits of birds in some low-lying areas is now beyond the nuisance stage, and the birds are actually considered as major pests.

Effect of sunlight on corn yield and standability

Yields of early maturing corn hybrids could be increased with satisfactory standability at the Virginia station by planting at heavier rates in alternate rows with soybeans. Increasing the planting rate of a full-season or late corn hybrid, however, reduces yield and standability. Full season hybrids in alternate rows with soybeans, but at the same plant rate per acre (12,000 to 14,000) have yielded about the same as when planted solid without the soybeans. In alternate rows with soybeans, the space between corn plants in the row must be shortened to maintain the plant rate. Corn in the alternate row method received more sunlight, but the amount of lodging and breaking was not reduced much. The cash value of the corn crop remained the same, yet, as a secondary benefit, soybeans brought in additional money.

Time to irrigate corn

Corn yields depend more on moisture supply during ear and kernel formation than on total seasonal supply, according to Nebraska station experiments (coop. USDA) at Scottsbluff. The best-timed irrigations--7 inches of water in three weekly applications begun just before tasseling--yielded 144 bushels per acre, compared with 153 bushels from 14 inches in six irrigations. Three irrigations completed before the tasseling stage used water only three-fourths as efficiently as the three best-timed applications. Yields generally increased with the number of irrigations, but grain per inch of water increased only to the second or third irrigation and declined sharply with additional applications.

Mass hybrid barley

A mass hybrid barley--developed by the California station (coop. USDA) from progeny of 28 varieties crossed in all possible combinations (378 crosses) after 25 generations of natural selection--yields equal to or higher than commercial barley varieties. Mass hybrids, suitable for feed crops but not for industrial use, have several advantages. They reduce chances of crop failure through unfavorable weather or disease conditions, which might lower yields of selected less variable strains, and are easier and cheaper to produce than backcrossed strains.

Winter oats from winter and early spring plantings

The Oklahoma station (coop. USDA) finds that certain winter oats, for example, Tennex and Stanton Strain 1, produce higher grain yields and test weights from January and early February seedings than do spring oats from any seeding date. Although best

oats yields in Oklahoma usually are obtained from winter varieties sown between September 15 and October 15, winter oats seeded in January and early February are combined more readily for they grow shorter and are less subject to lodging.

Sorghum vs. corn for silage

Comparisons in north Mississippi by the Mississippi station showed that until varieties of corn better adapted for silage are developed, farmers producing silage should grow sorghum (sorgo). Sart and Tracy have proved superior to other sorghums tested. Corn requires less storage space for the same amount of nutrients, yet sorghum endures much more dry weather and still produces a silage crop. With adequate phosphorus and potassium, 50 to 60 pounds of nitrogen per acre is advised for sorghum. If corn is to be used, fertilizer and cultural practices should be the same as for a good grain crop. Sorghum silage has produced about two pounds more milk per day than corn silage in a test where both groups of cows received all the silage they would eat with similar amounts of hay and concentrates. The better quality of the sorghum silage may have been responsible for the differences in milk production.

Wheat in the Red River Valley responds to nitrogen

That wheat on Bearden silt loam responds with higher yields when nitrogen fertilizers (40 pounds of nitrogen per acre) are applied, either before sowing or broadcast at different growth stages (with sufficient rainfall) was determined by the Minnesota station. The nitrogen supply of these soils, originally adequate for good wheat yields, has been greatly reduced by many years of cropping, too much fallow, and by burning straw and stubble. Whereas nitrogen tends to lower the bushel weight of grain, it shows its effects promptly in increased yield and protein content of wheat, even when applied 2 to 3 weeks before the crop ripens.

Wheat protein harmed by high temperatures during fruiting

That high temperatures combined with low humidity and perhaps drought during the 15 days before ripening are basic causes of poor baking quality in wheats normally superior when harvested in cooler weather was observed in experiments by the Kansas and other Plains States stations (coop. USDA). Maximum temperatures of 90° F. or above, continuing for several days during this 15-day period, are harmful to protein quality. When the 15-day summation of daily excesses above 90° is as much as 20°, slight damage usually follows, but severe damage results when there is an excess of 50° or 60°. Severity of damage apparently is increased by either low humidity or drought, factors often associated with high temperatures. In general, varieties characterized by flour of a short dough-mixing time are more likely to be injured than are those with a long dough-mixing time. Fortunately, varieties that produce the best quality of wheat under normal conditions also are among the best in seasons of high temperature.

Cotton varieties for stripper harvesting

Among seven cotton varieties selected for adaptation to mechanical stripper harvest and tested at four locations in western Oklahoma by the Oklahoma station, Parrott (CR-3) was consistently high in lint yield. Stormproof No. 1 (Lockett No. 1), Northern Star, and Lankart 57, recommended stripper varieties, were next in order. Gin turnout reflected varietal differences in both seed-lint ratio and trash in the harvested sample, the six top varieties ranging from 25 to 28 percent. Preharvest losses varied more for locations than variety, all varieties averaging satisfactory. Harvest losses were low for all varieties when good stripping conditions existed, results emphasizing the importance of uniform stands in stripper-harvested cotton.

Parrott and another strain CR-4, new cottons bred especially for mechanized production in the Southern Plains Cotton area, have satisfactory lint quality and from 10 to 15 percent higher lint yield than the variety currently most popular in the area. They have greater "storm-proofness" to reduce harvest losses, and CR-4 is also resistant to bacterial blight.

Time of planting soybeans in the South

The best time for planting soybeans in the Southern States, as shown by the Mississippi station (coop. USDA and Florida station) is when the minimum soil temperature attains 65° F. and after the day length reaches or exceeds 14½ hours. Planting under such conditions gives more rapid emergence, more rapid growth, higher seed yields, and better seed quality than earlier planting. Rapid emergence and rapid growth should contribute to greater ease in weed control. Medium- and medium-late maturing varieties have shown less reduction in bean yield from late plantings than do short-season varieties.

Soybeans deficient in manganese

Soybeans grown at 65° F. in soils deficient in manganese by the Ohio station showed severe deficiency symptoms in the leaves, not evident in those grown in the same soil at 80°. For a given soil temperature, severity of symptoms was greater at a high than at a low moisture content. This explains the absence of such symptoms in soybean tissues produced in warm, dry periods of the growing season.

Potatoes rotated with red top

When potatoes followed red top at the Rhode Island station, yields averaged more than 100 bushels per acre above potatoes in continuous culture, and the amount of fertilizer could be reduced below that in common use by potato growers. Red top was superior to timothy or red clover to alternate with potatoes. By rotating with red top and reducing fertilizer application on fewer acres, growers can save up to 30 percent on fertilizer costs and obtain as many potatoes as on the larger acreage in continuous potatoes.

Tobacco rotations are profitable

A tobacco-wheat-red top rotation led all other rotations in quality of leaf produced, based on price per pound received for flue-cured tobacco, and was among the top producers in average acre values in experiments of the Virginia station. All 2-year rotations tried gave larger yields and acre values than continuous tobacco. Rotations including legumes as vetch and crimson clover planted right after tobacco (never just before), and followed by a thick, lightly fertilized corn crop, have averaged the largest yields of both tobacco and corn and highest acre values for tobacco. The tobacco, however, has been of lower quality than in nonlegume rotations. Inclusion of legumes is not generally recommended, for analysis and smoking tests indicate that usually tobacco grown in rotations with legumes contains a higher percentage of nicotine and less sugar and is less desirable for cigarette manufacture than that in rotations without legumes.

Factors affecting sugar beet yields and quality

The Utah station (coop. USDA), from experiments on Millville silt loam and Millville fine sandy loam, finds that for good yields of high-quality sugar beets (a yield potential of not less than 20 tons per acre in the Great Basin), proper plant spacing, adequate fertilization, and timely irrigation must be combined with early planting and weed control. Plants should be spaced from 10 to 15 inches apart in rows from 20 to 22 inches apart. Spacing of sugar beet plants is a compromise between yield and convenience in mechanizing production. Barnyard manure, if available, should be used up to 12 to 15 tons per acre, about 250 pounds of superphosphate applied every 5 years, and from 60 to 100 pounds of nitrogen used per acre. Sucrose and purity percentages of sugar beets are increased by heavy, frequent irrigations and deficiency of available nitrogen. Light irrigation and heavy nitrogen fertilization depress sucrose and purity percentages. The plant should be kept growing as rapidly as possible from emergence to late summer, which often necessitates an irrigation before and one just after thinning, and also frequent light irrigations up to late summer. Irrigations from late summer to harvest may be spaced at 2-week intervals.

Intercropping sugarcane with food crops

That higher sugar yields can be obtained at a planting distance of 4 feet between rows of sugarcane than at an 8-foot distance, whether the cane is grown alone or intercropped, was determined by the Puerto Rico University station. Soybeans, native red and white beans, cowpeas, and other legumes can be grown to advantage with sugarcane. Cucumbers, melons, and tomatoes also can be grown with young cane without reducing sugar yields, yet corn is detrimental to sugar production. Such intercropping of sugarcane soils is deemed practicable and economical and worth considering as a means of increasing Puerto Rican food production on the same acreage.

FORAGE CROPS, PASTURES, AND RANGES

Management of Forage Crops

High-protein hay is possible

Research on mountain meadows by the Colorado station suggests the possibility of producing "super hay" which may take the place of costly protein supplements in winter feeding. Controlled irrigation and the application of 480 pounds of nitrogen per acre in the Gunnison area produced hay containing 2,400 pounds of crude protein per acre. Ordinary hay in this area averages only 150 pounds of protein per acre. If further feeding tests prove to be satisfactory, it may be possible for ranchers to set aside an area of their meadows to raise the high-protein hay and thus avoid the necessity of buying protein supplements.

Fertilization affects protein content

The influence of fertilization on the quality of protein varies in different forage plants, according to studies by the Oklahoma station. With Sudan grass, although the yields were greatly increased by fertilizers, the relative amounts of the principal amino acids remained essentially the same. On the other hand, fertilization of alfalfa brought about a substantial variation in the leaf-stem ratio and, since the composition of the leaf and stem protein differs, the composition of the whole plant is affected by fertilizer treatments.

Influence of soil elements on milk flow

As a result of more than 35,000 chemical determinations over the past 9 years on soils, crops, milk, and blood of cows, the Michigan station concludes that soil fertility does not influence the composition or nutritive value of cow's milk.

The New Hampshire station reports that cobalt, iron, copper, and iodine deficiencies have been produced in dairy cattle by feeding forage grown under conditions of heavy fertilization of the soil.

Birdsfoot trefoil survives drought

The value of legumes in pastures was strikingly shown by the Illinois station at Dixon Springs. After two successive dry years, birdsfoot trefoil was one of the few pasture legumes which survived, and it produced over 3 tons of dry matter per acre. Lambs fattened on this pasture for early market sold in June for $29.50 per hundredweight. Lambs on grass pasture alone did not fatten and were sold the following fall after feeding for only $20 per hundredweight.

Sheep gains upped by irrigation

Supplemental irrigation in humid areas plays as important a part on pastures as it does for cereal or row crops. The Indiana station found no difference in animal daily gains on irrigated and nonirrigated pastures, but a heavily grazed, irrigated ladino-

Newly developed crop varieties

Crop	Variety	Station and cooperation	Type	Noteworthy characteristics	Resistance to crop pests	Adaptation
Wheat.....	Bowie.....	Texas..... USDA	Feed (near spring)	Outyields Austin with grain of higher protein content and superior to other feed varieties. Not for bread.	Resists leaf rust and many races (including 15-B) of stem rust.	Central and South Texas.
"	Knox.....	Indiana..... USDA	Soft red winter.	Beardless, white-chaff, medium short-straw, extremely early. High bushel weight. Outyields commercial varieties currently grown in Indiana. Satisfactory milling and baking.	Resists leaf rust, escapes stem rust, resistant to mosaic virus and many races of loose smut; susceptible to stem rust, which it may escape, and to hessian fly.	Indiana.
"	Onas 53....	California...	White spring.	Awns add 7 percent in yield and 1 pound in test weight.	Resists stem rust and bunt.	California under irrigation and higher rainfall dry-land areas. Avoid shatter areas.
"	Sentry.....	North Dakota. USDA	Durum	Under rust conditions, should yield better than Mindum or Stewart; earlier than standard durum, good quality, strong and shorter straw.	Fairly tolerant to 15-B rust; does not rust as soon as other varieties.	Durum area.
"	Taylor.....	Southern States USDA	Soft winter.	Outyields Purplestraw, which it exceeds in protein; more winter-hardy than Atlas. Tall stiff straw.	Resists leaf rust, and some stem rust races; moderately susceptible to wheat mosaic. Resists lodging.	Southern States.
"	Travis.....	Texas..... USDA	Feed (near spring)	Superior for late spring pasture, hay, and silage. Not for bread.	Resists leaf rust, and many races (including 15-B) of stem rust.	Central and South Texas.
Barley....	Atlas 54....	California... USDA	Coast..	Generally outyields Atlas 46 when winter sown and has smooth awns.	Some resistance to scald and mildew, as Atlas 46.	California State-wide wherever Atlas has been grown.

Crop	Variety	Station and cooperation	Type	Noteworthy characteristics	Resistance to crop pests	Adaptation
Barley--(Con.)	Hiland.....	Wyoming.... USDA	Spring.	High yields, semismooth awns, high bushel weight, and clean threshability. Excels under irrigation; equals Trebi and surpasses Frontier on dry land.	Resists loose smut strains, ergot, and bacterial blight, and lodging.	Irrigated land in Wyoming.
"	Hudson	New York (Cornell) USDA	Winter.	Surpasses Wong in yield, winter-hardiness, bushel weight, and scald resistance, and has equally stiff straw.	Resists mildew and scald.	New York.
Oats.....	Cimmaron..	Oklahoma ... USDA	Winter (intermediate)	Matures early and yields well from either spring or winter planting. Better than Wintok for winter pasture, winter hardy--good test weight. Equals Forkedeer in resistance to lodging.	Resists Victoria blight, soil-borne viruses; considerable resistance to smuts. Susceptible to greenbugs, but makes remarkable recovery when greenbugs are removed.	Northern and western Oklahoma.
"	Craig.....	New York (Cornell)	Spring (midseason)	High yielding, short medium-stiff-strawed; matures 4 to 6 days later than Mohawk or Clinton. Plump white kernel.	Resists crown rust, moderately resistant to Race 45; susceptible to Race 7 of stem rust.	Western New York.
"	Dupree	South Dakota. USDA Kansas	Spring (early)	High drought resistance. Very early, fine stemmed, yellow grain, good test weight.	Resists stem rust (race 8), leaf rust, Victoria blight, smut, halo blight; less susceptible than Clinton to crown rust Race 45.	Central South Dakota.
"	Seminole...	Florida ..... USDA	Winter.	Very early, short, strong straw, good early forage crop and excellent grain yield.	Crown rust resistance (from Santa Fe); resists Florida collections of smut but is susceptible to stem rust.	Suwanee Valley southward.
"	Sunland....	Florida ..... USDA	Winter.	Early, tall, excellent grain and forage yield.	Crown rust resistance (from Landhafer); susceptible to stem rust and Florida collections of smut.	Oats area of Florida.

Newly developed crop varieties--Continued

Crop	Variety	Station and cooperation	Type	Noteworthy characteristics	Resistance to crop pests	Adaptation
Oats--(Con.)	Waubay.....	South Dakota. USDA	Spring. (late)	Stiff straw, light yellow grain.	Resists stem rust race 7 but not race 8; tolerant to leaf rust, intermediate to Septoria and halo blight, resists smut.	Eastern North Dakota, especially northeast.
Rye.....	Adams.....	Wisconsin...	Winter.	Uniform yellow kernels, yields 2 to 3 bushels above Imperial, which it resembles in straw and maturity.	Resembles Imperial in rust resistance.	Wisconsin.
Sorghum .	Combine Sagrain	Alabama	Grain..	Good yields, late maturity; loosely branched seed head, brown seedcoat, 4 feet high.	Resists lodging; has not been damaged to any extent by disease, insects or birds.	Southern Alabama.
Cotton ...	Auburn 56..	Alabama	Upland.	High yields, about 1-inch staple. Good agronomic qualities.	Resists fusarium wilt; tolerant to root knot nematode.	Alabama.
"	Pima S-1 ..	Arizona	American Egyptian	Outyields Pima 32 by 10 percent, equals it in yarn strength. Compact plant habit.		Arizona.
Soybean..	Lee	Southern States USDA	Grain..	Glossy yellow seed with a black hilum. Compared to Ogden, which it may replace extensively, Lee yields more, has slightly higher oil content, and sounder seed coats and is very resistant to shattering.	Resists bacterial pustule, wildfire, frogeye, and purple seed strain; more tolerant than Ogden to root knot nematode.	Mid-South from southeastern to Atlantic Coast.
"	Renville....	Minnesota... USDA	Grain..	Good yield, medium, yellow seed with light brown hilum, superior in oil content. Matures between Blackhawk and Ottawa Mandarin.	Resists lodging.	Minnesota: southern, south-central, central corn zones.
Peanuts..	Florispan..	Florida	Runner.	High yielding runner with short smooth pods and nuts which blanch well-suitable for salting, peanut butter, and candies, with shorter growing season, it outyields	Low percentage of concealed damage.	Florida.

Crop	Variety	Station and cooperation	Type	Noteworthy characteristics	Resistance to crop pests	Adaptation
Peanuts--(Con.)				Dixie Runner and Florida Runners, and has more sound nuts. Also promising for feed.		
"	NC-1	North Carolina	Upright Bunch	High yields, large, very uniform seed high in market quality, averaging over $1 more per bag, flesh-colored seedcoat.	Average reaction on stem rot (wilt), leaf spot, nematodes.	North Carolina.
"	NC-2	North Carolina	Semi-bunch	High yields, large very uniform seed, very high in market quality, averaging over $1.40 more for bag. Flesh-colored seedcoat, very loosely attached.	High resistance to stem rot (wilt), good resistance to leaf spot, average reaction to nematodes.	North Carolina.
Potato	Delus.....	Delaware.... USDA	Medium to late.	High yields, attractive and good for cooking.	Resists late blight.	Delaware.
"	Osseo	Minnesota...	Early..	Yields a high percentage of tubers above 2-1/2 inches in diameter. Potatoes are white, smooth, round, blocky, and uniform in size.		Home garden or market in Minnesota.
"	Redglo.....	Nebraska....	General purpose	Bright dark red tubers--suitable for boiling and mashing and fairly good for baking and chips or french fries.		Western Nebraska dryland and irrigation.
Sweet-potato	Earlyport..	Louisiana ...	Moist flesh.	Earliest, highest yielding of the Porto Rico type; copper skin and deep orange flesh, good canner and holds shape well in can. Roots become of jumbo size when grown much beyond 90 days.	Not resistant to sweet-potato diseases.	Louisiana.
"	U.P.R.#7 .	Puerto Rico .	Moist flesh.	Productive in heavy soils, smooth, uniformly colored skin; deep orange flesh, high carotene content.		Tropics.
"	Shoreland..	Maryland....	Moist flesh.	Heavy vine, light golden skin, uniform deep orange flesh,	Resists wilt and scurf, moderate resistance to	Maryland.

Newly developed crop varieties--Continued

Crop	Variety	Station and cooperation	Type	Noteworthy characteristics	Resistance to crop pests	Adaptation
Sweet-potato--(Con.)				high carotene content, very good keeping quality, and good processing quality.	black rot, susceptible to pox.	
Tobacco...	Burley 11A and 11B	Tennessee... Virginia USDA	Burley.	Equal to susceptible varieties in yield, grade, and acre value. Burley 11A has a slightly thinner leaf, while Burley 11B is more resistant to black shank.	Resistant to black shank, root rot, and (in first test) fusarium wilt.	Burley area on black shank infested land.
"	Dixie Shade	Florida ..... USDA	Cigar wrapper.	Advantages of Dixie Shade over the widely grown Rg wrapper variety are resistance to root knot, larger leaf numbers and width and more body, higher yield, better appearance, less susceptible to spots on cured leaves; and better field characters.	Resists black shank, root knot.	Florida.
"	Va. B-29...	Virginia.....	Burley.	Leaves have yellow cast and are spaced close together. Matures a little later than Ky. 16. It has averaged 2,348 lbs. per acre valued at $1,394, $123 more than Ky. 16.	Black root-rot and mosaic.	Virginia.

bromegrass pasture produced about 500 more sheep days per acre for the grazing season than did a similar nonirrigated pasture.

Irrigating pastures for milk cows

The Nebraska station compared lactating cows on an irrigated ladino-bromegrass pasture with a comparable group in dry lot. The pasture saved 5 pounds of hay, 35.9 pounds of silage, and 4.1 pounds of grain per cow day, and these savings amounted to $114 per acre for the grazing season.

During an exceptionally dry pasture season the North Carolina station found that supplemental irrigation increased milk production 35 percent, total digestible nutrient yield 109 percent, days grazed 70 percent, and carrying capacity 100 percent. However, it is believed that only high-yielding, well-fertilized pastures can be irrigated profitably.

The Utah station found that cows on a good irrigated pasture produced from 60 to 75 pounds of milk per day on pasture alone. Cows receiving grain in addition to pasture did not exceed this production.

Processing and Utilization of Forage

Nutrient factor in green oats

Young green oats may contain some factor other than conventionally recognized nutrients and may cause cows to produce greater quantities of milk according to Alabama station experiments. Three groups of cows on an alfalfa hay concentrate mixture were fed young green oats for a 14-day period in such quantities as to replace the 0, 50, and 100 percent levels. Milk production was significantly increased in the cows fed green oats, but there was little difference between those at the 50 and 100 percent levels. This suggests that a limited quantity of grazing would increase the milk production of cows fed poor quality roughage.

More milk with temporary forage

The use of temporary forages can probably do more to increase milk production and reduce production costs than any other feeding program now available, Georgia station research showed. Two groups of cows on alfalfa and lespedeza hay were grazed 2 hours per day on a temporary forage. During a 30-day period the group on alfalfa hay gave an average increase of 6 percent in milk production and averaged 14 pounds gain in weight. The group on lespedeza hay gave a 3-percent increase in milk production, but lost an average of 21 pounds of body weight.

Bluestem pastures winter steer calves

Tests at the Kansas station indicate that the best way to winter steer calves that are to be grazed and sold off grass appears to be on native bluestem pasture with a ration of 1 pound of protein, minerals, and salt. On such a ration from December to July, 416-pound steers gained 275 pounds at a cost of $9.72 per 100 pounds of gain. It cost $13.87 per hundred for steers in dry lot and fed prairie hay.

Protein saved by early cutting

The quality and nutritive value of prairie hay is influenced greatly by the stage of maturity when harvested. The South Dakota station found that hays cut at the heading stage averaged 7.43 percent protein. Hay cut in the seed-ripe stage averaged 6.11 percent protein, but when the grass was mature and weathered the protein dropped to 5.94 percent. In feeding trials with calves the three cuttings of hay were fed with soybean meal pellets in amounts to give 10 percent total protein in the ration. Equal rates of gain were obtained but there were large differences in the amounts of soybean meal

required. The early-cut hay required 177 pounds of soybean meal per ton; the medium-cut hay, 253 pounds; and the late-cut hay, 313 pounds. At a cost of $100 per ton for soybean meal pellets, the early-cut hay was worth $3.80 more than the medium- and $6.80 more than the late-cut hay.

Time for cutting Johnson grass

The Mississippi station conducted feeding trials with dairy heifers on Johnson grass hay and found that the rate of gain was highest when the hay was cut in the boot stage. Even though the dry matter yield was less, it produced 1.24 times as much gain per acre as did hay cut in the late milk stage. Crushing the stems at the time of cutting did not have much effect on gain in body weight, but it was learned that uncrushed hays were consistently lower in carotene.

Profits in cutting timothy early

In a similar study with timothy hay the Missouri station found that 1 ton of early-cut hay was worth 2 tons of mature timothy hay as a wintering ration for calves. In both cases the hay was supplemented with 1.5 pounds of soybean oil meal daily. Steers fed the early-cut hay needed 593 fewer pounds of hay and 144 pounds less of soybean oil meal per hundredweight of gain. They also consumed 21 percent more hay, thus proving its palatability.

Rotating pastures daily

Rotating pastures for dairy cows is increasing in importance. The Montana station conducted a 60-day trial with milking cows to compare the carrying capacity of a 10-day rotated pasture and a 1-day rotated pasture. Cows that had access to a new strip of pasture each day consumed 247 more pounds of TDN in the form of roughage than did cows that were rotated to a new pasture every 10 days. The cows that were rotated daily returned $1.14 more each 10-day period than the cows on the 10-day rotated pasture.

Preventing silage spoilage

The value of various preservatives in preventing spoilage and silage losses is open to considerable question. Tests at the Pennsylvania station indicate that sodium metabisulfite produces superior silage and prevents spoilage. The Ohio station found the same to be true of sulfur dioxide. On the other hand, the New York (Cornell) station found that sodium bisulfite reduced both juice and fermentation losses slightly but not enough to cover the cost of the chemical. It was concluded that early-cut, unwilted forage can be made into satisfactory silage without a preservative.

Medium dry silage increases gains

The Vermont station has shown that the amount of moisture in grass silage may affect its nutritive value. One group of identical twin calves was fed low dry-matter silage, averaging 22.8 percent, and another group was given medium dry-matter silage, averaging 31.6 percent. The group on the drier silage ate 9 percent more dry matter and gained 10.6 percent more in weight. It was also determined that dry-matter losses were higher in the low dry-matter silage.

Pasture mixtures lower feed bill

The Virginia station reports that the rate of concentrate supplementation for dairy cows can be greatly reduced if good, well-managed pasture mixtures are available. Cows grazing pure ladino clover, regardless of the concentrate supplement provided, produced more milk than cows grazing on orchardgrass and ladino clover mixture.

Forage Crop Seed Production

Alfalfa seed harvesting improved

One of the major factors in profitable forage crop seed production is the prevention of seed damage during harvesting. The California station has shown that three out of every four seeds damaged in the harvesting operation fail to produce a normal plant. Furthermore, damaged seed deteriorates more rapidly than sound seed. In 1948, when the research on harvester damage was initiated, 27 percent of all alfalfa seed submitted for certification was rejected because of low germination. In 1953, only 1.6 percent of more than 34 million pounds of seed was rejected because of low germination as a result of harvester damage.

Preharvest sprays cut costs

The California station has also found that preharvest chemical sprays to cure alfalfa and clover seed crops can cut harvesting costs and seed losses. Crops dried with chemical sprays can be directly combined, thus eliminating mowing, windrowing, and vacuuming fields to recover shattered seed. Seed losses in spray-cured fields were less than 4 percent of the total yield.

Nitrogen helps fescue seed yields

That nitrogen has a marked influence on yields of Kentucky 31 fescue seed is shown by a study made by the Kentucky station. Single broadcast applications of 150 pounds of ammonium nitrate per acre, made February 25, March 17, and April 7, on a 4-year-old sod, produced 480, 398, and 403 pounds of seed per acre, respectively. An untreated series of plots produced only 243 pounds of seed per acre.

Length of day influences seed

Applied knowledge of photoperiodism enables the plant breeder to accelerate his breeding program and to observe plant variation in forage and seed production. The Mississippi station has shown that strains of Dallis grass differ significantly in the production of viable seed. The best seed production occurred under a 14-hour photoperiod. These tests indicate that low night temperature during early growth may stimulate seed head formation. Fewer culms are produced by Dallis grass as the photoperiod lengthens. Therefore, the reduction in forage production in the summer may be due in part to photoperiod response in addition to drought and high temperature.

FORESTRY

Seed and seedling studies

The Mississippi station learned that the source of loblolly pine seed can be an important factor in developing seedling resistance to late spring frosts. Seedlings grown from seed collected in Winston County escaped injury from May 4 and 5 frosts, whereas those grown from Adams County seed, 130 miles farther south, were so severely damaged that about one-third of the seedlings were killed.

Material differences in the rate of growth and form of jack pines grown from seed obtained from different geographical locations were recorded by the Minnesota station. Trees from far northern seed were slower growing than those from seed obtained farther south.

Acorn production of the black, blackjack, scarlet, post, and white oaks was studied by the Missouri station and was found to vary considerably from year to year without following a regular cycle. The longest interval between good seed years was four and no general acorn crop failure was recorded. Scarlet, black, and white oaks were more prolific than post and blackjack oaks as measured in viable acorns. Wildlife showed no apparent preference for acorns of any one species.

Killing undesirable growth

Studies by the Alabama station of methods of killing weak and undesirable trees in the forest stand indicated that large trees can be killed by girdling, for as a rule they do not reproduce from sprouts. Medium-sized trees can be killed by placing poison into frills cut into the trunk. Small trees can be cut and poisons applied to the stumps to prevent sprouting. Destruction of the inferior trees not only improves the stand, but results in the more rapid growth of the remaining trees.

Defective, ill-formed trees may be readily killed, according to the New Hampshire station, by insertion under the bark of small tabs of blotting paper, treated previously with sodium arsenite. Each tab contains approximately $\frac{1}{2}$ gram of the poison. In white pine, trees up to 4 or 5 inches in diameter can be killed with one tab. Larger trees require more tabs according to their size and habit of growth. A special tool, similar to a slightly bent chisel, was devised for raising the bark for insertion of the poisoned tab.

PROGRESS IN SOIL SCIENCE

Fertilizer Needs

Making phosphorus more available

Removal of calcium from the crystal of mineral-held phosphorus is important in making phosphorus available to plants as shown at the Missouri station. Applications of rock and superphosphate were much more effective when accompanied by a hydrogen-saturated colloidal system, such as H-amberlite, having a high attraction for calcium.

Placement needs vary according to plants

Knowledge of the nature and extent of plant root systems is important for satisfactory fertilizer application. Using a tracer technique with radioactive phosphorus, North Carolina scientists showed that exact placement of top-dressing and supplemental fertilizers on corn is not important because corn has an extensive root system. On the other hand, cotton has a relatively limited root system so that the fertilizer must be placed at the right depth and distance from the plant to give the greatest benefit.

Correcting specific deficiencies

The California station has identified and described foliar symptoms of potassium deficiency in almond and olive trees.

For cotton fertilization in the San Joaquin Valley, nitrogen was found to be the most important element influencing production. Phosphorus fertilization is required on some soils. Potassium fertilization did not increase yield or quality and brought yield reductions in some instances.

Lime aids revegetation of strip-mine areas

A number of experiment stations are seeking ways to revegetate extensive areas where coal has been removed by strip-mining methods. The Ohio station had greatest success with trees and forage crops in areas where limestone was found above the coal seam. It also achieved satisfactory reestablishment of growth in acid areas through the use of adequate lime and fertilizer treatments.

Minor element needs

Molybdenum deficiency in cauliflower was corrected by liming seedbeds to pH 6.5 and field soils to pH 5.5 at the Florida station. On Leon fine sand, a soil type that is being extensively developed in Florida, copper and boron applications were necessary for good

crop growth. Other minor elements were not limiting for growth of clover and grass in pasture mixtures.

Manganese nutrition

Manganese deficiency was shown to be associated with soil moisture and temperature conditions at the Ohio station. In greenhouse tests, soybeans grown in a manganese-deficient soil held at a temperature of 65° F. exhibited severe manganese deficiency symptoms, whereas beans in the same soil at 80° showed none. At a given temperature the severity of deficiency was greater at a high than at a low soil moisture content.

Boron increases clover yield

Marked increases in yields of crimson clover seed as a result of boron fertilization are reported by the Alabama station. In general, the soils of heavy texture were found to contain sufficient boron. On sandy soils maximum increases in yield were obtained from the application of 10 pounds of borax per acre.

Slow-drying foliar spray

A new type of solution for spraying chlorotic plants under semiarid conditions has been developed by the Arizona station. The earlier sprays dried too quickly for thorough leaf coverage and penetration. The base of the new material is a 1-percent citric acid solution plus a detergent. The citric acid serves as a buffer and dries on the leaf as an adhesive film. Iron chlorosis has been corrected, even in members of the grass family, by application of iron sulfate in the spray solution.

Soil Chemistry and Mineralogy

Phosphorous fixation

Phosphorus fixation in the presence of montmorillonite is by associated compounds and ions and is not caused by fixation in the clay lattice, according to results obtained at the Kansas station. When the clay was hydrogen-saturated, phosphorus fixation was due to iron and aluminum oxides associated with the clay. No fixation occurred when these oxides were removed.

Ion adsorption of clay crystals

The Indiana station learned that clay crystals in acid soils hold adsorbed ions in addition to hydrogen. The results of experiments indicate that when a soil becomes acid the adhering hydrogen penetrates the clay crystal and displaces aluminum which is then adsorbed on the crystal surfaces. Such adsorbed aluminum would be expected to be toxic to plants. In addition, the aluminum would contribute to the precipitation of fertilizer phosphorus in relatively unavailable compounds.

Ion constancy in plants

The cation and anion constancy of crop plants was analyzed at the New Jersey station. In recognition of the greatly increased use of anhydrous ammonia, attention was given to ammonium and nitrate forms of nitrogen. In solution culture tests ammonium nitrogen reduced the absorption of other cations including calcium, manganese, and magnesium. Absorption of anions including sulfur, phosphorus, and chlorine was facilitated by the ammonium nitrogen material, with the result that the cation-anion ratio remained constant.

Moisture influence on nutrient uptake

The movement of nutrient cations (calcium, potassium, magnesium) between the soil exchange complex and plant roots has been shown to be affected by variations in

soil moisture according to research at the Arkansas station. The percentage decrease in certain exchanges, at the moisture wilting point, compared with that at moisture equivalent was 50, 65, 85, and 72 for Lakeland, Ruston, Richland, and Crowley soils, respectively, but only 14 and 19 percent for Sharkey and Houston soils. The percentage of calcium and magnesium increased whereas potassium and sodium decreased at the higher moisture levels. The data emphasize the importance of favorable soil moisture levels for optimum usage of nutrients by plants.

New test for potassium

A new soil-testing technique to provide better evaluation of the potassium-supplying ability of soils is reported by the West Virginia station. A high capacity cation exchange resin is used for extraction of potassium from the soil. In addition to the reliability provided, the test procedure requires less time and special equipment than most other methods.

Microbial Activities in Soil

Benefits from organic matter breakdown

Gum-like substances produced in the microbial decomposition of organic matter are important in improving the structural conditions of the soil. Research at the Wisconsin station shows that these microbial gums or polysaccharides are effective in forming crumbs or soil aggregates. Such aggregates, being far larger than individual silt or clay particles, provide greater pore space for air and water movement and more favorable conditions for root development. High fertility, proper liming, and growth of grass-legume crops with extensive root systems all favored vigorous microbiological activity and the development of good soil structure.

Dried sewage sludge as fertilizer

Nitrification studies with sewage sludge to evaluate the material for soil application have been conducted at the Massachusetts station. Presence of the sludge did not retard nitrification of ammonium sulfate, cottonseed meal, and dried blood in the soil. Results indicate that dried sludge could be used advantageously as an additional source of soil organic material.

Breakdown of herbicides by micro-organisms

Isolation and identification of micro-organisms capable of breaking down herbicides in the soil is under way at the Pennsylvania station. Organisms of the Corynebacterium group are able to decompose 2,4-D at a rapid rate. Similar, but as yet unidentified, organisms have been isolated which have the ability to decompose 2,4,5-T.

Effect of insecticides on nitrification

In research on the effects of insecticide on the nitrification process in soils, the West Virginia station found that BHC (benzene hexachloride) apparently would have little or no effect upon the nitrification process up to 400 pounds (10 to 12 percent gamma isomer) per acre. This application would be equivalent to 200 p. p. m. Parathion has no inhibitory effect up to 500 pounds per acre or 250 p. p. m., which would be equivalent to the amount that would be applied in 25 years at the recommended annual rate. It also seems that systox and chlordane could be used with no danger to the nitrification process in amounts up to 130 pounds and 2,500 pounds per acre, respectively.

Symbiotic nitrogen fixation

The efficiency of strains of root nodule bacteria of legumes is under study at the Illinois station. Soybean selections have been made which differ widely in apparent resistance to nodule formation. Other studies concern the value of legume inoculation with

the nitrogen-fixing Rhizobia on new land and on soils where the organism is already present.

Soil Physical Properties and Water Management

Fertilizer efficiency under irrigation

Supplemental irrigation of flue-cured tobacco was found to be profitable in Florida station trials. Use of irrigation increased fertilizer efficiency and gave higher yields of better quality tobacco. On irrigated areas 800 pounds of fertilizer per acre produced as high yields as double this amount on unirrigated land.

Irrigation increases corn and cotton yields

Supplemental irrigation of cotton at the Arkansas station increased yields an average of 35 percent during a 4-year period. Maturity of the crop was delayed about 2 weeks, with no discernible effect on quality, as a result of irrigation. In a 1-year test, corn yields were increased markedly by supplemental irrigation.

Water retention qualities in irrigation

Knowledge of moisture retention and release characteristics of the particular soil in use is essential for efficient water management. According to the Utah station, the amount of water that can be removed from the soil by plants varies with different soil types and changes greatly within a single type depending on physical soil conditions. Too frequent irrigation results in deep percolation and excessive evaporation. At the other extreme, crop growth is seriously limited if moisture supply is reduced to or near the wilting point. The Utah research shows that fertilization practices need to be adjusted to moisture availability if maximum returns are to be obtained from both the fertilizer and water used.

Minimum tillage best for soil

Interrelations between tillage intensity, water management, soil physical condition, and crop yields have been investigated at the Arizona station. Tillage operations tend to compact the soil which reduces aeration and rate of moisture penetration. Compaction retards normal root development thereby reducing plant yield. Results indicate that, after properly breaking the soil, subsequent tillage operations should be kept to a minimum consistent with preparation of a satisfactory seedbed. Additional tillage operations increase production costs and may seriously damage structural conditions of the soil.

Adding fertilizer in subsoiling

Studies of subsoiling at the Indiana station show that if fertilizer is added to the subsoil as part of the operation, its benefits are increased and its effectiveness is prolonged. Addition of fertilizer induces deeper rooting of plants thus increasing available moisture and increasing yields. At the same time the root growth improves structure of the subsoil and prolongs the water conservation benefits of the subsoiling operation.

Effect of management on soil properties

Effects of cropping and soil management practices on structure and productivity of the soil are reported by the Kentucky station. Yields and quality of tobacco have been determined from areas under continuous cultivation for 50 years, in a 3-year rotation with small grain and meadow, and from tobacco after an old bluegrass sod. Significant reduction in degree of aggregation and related physical properties was found to result from continuous cultivation as compared with the rotation and sod conditions. Both yield and quality of tobacco decreased with deterioration of soil physical conditions.

Plants and the Elements

Root responses to minerals

Studies of colloidal clay by the Missouri station made in connection with behavior of plant roots suggest that mineral nutrients produce root responses separate from those visible in the plant top. The studies showed that root movement downward is not only in response to drying of the soil, but also in response to fertility, indicating that this factor must be assessed separately from the moisture factor.

Calcium movement in plants

The movement of calcium from shoot to root is insufficient to support root growth, according to radioactive calcium tracer studies made by the Florida station. When Ca^{45} was applied to one portion of a split root system of a peanut plant, only minute amounts could be detected in the untreated portion of the root system. Likewise, when Ca^{45} was applied to the lateral roots near the surface of deep-rooted plants, such as Hubam clover, in most instances there was not enough downward movement of Ca^{45} into roots at the lower depths to be detected. Similar results were reported by the Michigan station.

Phosphorus migration

Experiments at the Michigan and New Hampshire stations reveal that phosphorus applied to the leaves migrates readily to all plant parts in strawberries and potatoes. Further studies are under way to learn whether this method of phosphorus application offers practical and economic advantages to growers.

Vanadium needed by green plants

Vanadium is an essential element in the metabolism of green plants, according to the California station. Whereas vanadium had been regarded previously as a contaminant with iron, their experiments confirmed that it is actually an essential minor element. The California discovery may help correct some hitherto unexplained crop failures in certain soils. Beneficial effects of vanadium on wheat and other crops have already been shown in New Zealand.

Helping plants get more iron

In experiments at the New Jersey station mixing the chelating agent, ethylenediamine tetraacetic acid (EDTA), with ferrous sulfate and magnesium sulfate in culture solutions at pH 7.0, increased the amount of iron availability to plants. This mixture of chemicals, combining inorganic salts with the organic compound, offers a practical means to reduce iron chlorosis in the field and to increase iron availability.

Molybdenum level for cotton

Research at the Texas station showed that cotton should not be grown in soils containing more than 1.6 p. p. m. of available molybdenum if the seed is to be used for feed. On the other hand, reasonable yields were obtained in soils containing more than 20 p. p. m. of molybdenum, a level which is toxic to many crop plants.

Nutritional needs of cotton

In studies with nutrient solution cultures at the Texas station, sodium was found to partially replace both calcium and potassium in nutrition of the cotton plant. In case of the calcium substitution, the mechanism may be one of mobilization of calcium in older plant tissues which would permit reuse of the element for later development and fruiting of the crop. No evidence that sodium influenced the movement of potassium within the plant was observed.

Plants may utilize organic nitrogen

At the Montana station plant growth was stimulated materially following the application of certain amino acids to the soil. In a related study at the Missouri station, algae cells utilized urea and asparagine as a nitrogen source in preference to ammonium nitrate. Thus there is a possibility that plants may be able to take up nitrogen in organic as well as inorganic form.

Fertilizer sufficiency values

Although "deficiency values" have been tentatively determined for certain elements in certain crops, there is very little information concerning "sufficiency values" for the various elements in crop plants. In the absence of the latter type of information, it is admittedly difficult to evaluate an analysis of plant material once it has been made. The economic significance of sufficiency values would be twofold: Presumably, farmers could increase crop yields by the timely application of needed fertilizer, and, contrariwise, savings could result from the withholding of fertilizer elements that are already present in the plant in optimal amounts for maximum yield. Data have been obtained by the Maryland station which should make possible the accurate selection and setting of sufficiency values for various elements in different crop plants. Although more precise limitations to these values must await the collection of additional data, there are at least tentative values for use in an interpretation of a given analysis of plant material.

Metabolism Studies

Boron steps up sugar movement

Enhancement of sugar and hormone movement in plants by the addition of boron was found by the Maryland station to hold not only for sucrose but also for glucose and fructose. Boron not only stepped up translocation of 2,4-dichlorophenoxyacetic acid, but also indoleacetic, naphthalene acetic, and 2,4,5-trichlorophenoxyacetic acids. These findings are now being put to practical tests to learn whether inclusion of boron can improve the action of growth regulators.

Initiating flowering of plants

Studies at the Indiana station disclosed that the nonphotosynthetic fixation of carbon dioxide may play a critical role in flower formation, both under the influence of daylight changes and changes in season. The interaction of temperatures and auxin (a growth regulator produced in the plant) and their varied influence on promoting flowering in different plants were observed in the experiments. Variations in flowering were brought about in a wide variety of species. Subsequent field tests suggest practical usefulness of the findings in altering the earliness of certain crops.

Chemistry of setting fruit

Missouri station scientists sought to establish the function of a plant hormone as it affects fruit development, carbohydrate metabolism, and respiration. They identified the hormone as the ethyl ester of indoleacetic acid. The highest concentrations were found in the endosperm, from which the hormone passed into the embryo and other adjoining tissues. In apples, the indoleacetic acid oxidase system was most active in the rapidly developing embryos. It seems to regulate concentrations of the hormone in the embryo, thus controlling metabolism and growth. Both the hormone and its ester were shown in preliminary studies to be oxidized by the enzyme. The hormone seems to be produced mainly in the endosperm from which it moves into the embryo where it serves as a catalyst of metabolism. In the Missouri experiments, scientists duplicated the natural metabolism by using a synthetic ester of the hormone on nonfertilized ovaries and successfully produced fruit in both tomato and corn plants. Thus it is probable that indoleacetic acid and/or its ethyl ester are the primary chemicals active in the early development of fruit.

Water absorption by leaves

Experiments at the Arizona station have shown that the leaf of a plant can be a primary water-absorbing organ. Absorption of water through the leaves thus becomes an important consideration in sprinkler irrigation. In a humid atmosphere, absorption through the leaves is of sufficient magnitude to cause excretion of water from the roots.

Toxicity of creeping indigo

Creeping indigo is one of the few legumes that will compete successfully with aggressive grasses in the pastures of the Tropics. When farmers in Hawaii reported that creeping indigo fed in quantity was harmful to cattle and chickens, the Hawaii station undertook analytical tests to learn the nature of the reported toxicity. They identified the toxic material as beta-nitropropionic acid. The station also developed a quantitative test for this compound so sensitive that only a few leaves are necessary for analysis. The creeping indigo leaves also showed a high concentration of nitrites that probably account for part of the toxicity. The determination of the nature of the toxicity and the development of the simple chemical test should be useful in breeding and selecting nontoxic strains of this valuable forage legume for the Tropics.

Separating extracts and tissues

The California station has developed a chromatographic column for purifying extracts from plant or animal tissues. It consists of fine granules of alumina coated with a microcrystalline mineral oil packed into a glass tube to form a column several inches long. When extracts from plant and animal tissues are passed through this column, the fats and waxes which interfere with chemical and biological analysis for contaminating insecticides and fungicides are removed so completely that analysis in most cases can be made without further treatment.

WEED CONTROL

In Pasture, Field, and Cereal Crops

New use for CMU

The chemicals 2,4-D and 2,4,5-T have been used successfully for controlling a variety of undesirable woody plants and perennial weeds in pastures. To control the species not affected by these compounds, other new herbicides are greatly needed as foliage applications. CMU (3-(p-chlorophenyl)-1, 1-dimethylurea), usually regarded as a soil sterilant, was found promising by the Hawaii station. CMU will kill most woody plants except lantana, yet has little effect on important pasture species like Dallis and Guinea grasses. Applied in the form of 25 percent CMU pellets, this herbicide is of particular value in the treatment of inaccessible areas. In the pellet form, CMU is easily applied and is much lighter than herbicidal solutions.

Chemical control for chickweed

Effective control of chickweed in alfalfa and other legumes with CIPC (isopropyl) N-(3-chlorophenyl) carbamate) at 1 to 3 pounds per acre has been reported by the Massachusetts, Delaware, Pennsylvania, and other stations. The Utah station found that CIPC also gave excellent control of dodder in alfalfa; in some instances there was a 100-percent increase in yield of seed. Other experiments by the Utah station showed that repeated applications of 2,4-D and 2,4,5-T were effective in reducing and eliminating wild rose and chokeberry.

Weed-free flax and alfalfa

Maleic hydrazide promises to control while cockle and night-flowering catchfly in alfalfa grown for seed, according to the Minnesota station. Weed experts there have also

worked out practical methods for using herbicides to control weeds in flax. Certain tillage practices in corn or oats preceding flax reduced weeds in the flax and also the number of annual weed seeds in the soil. Subsequent spraying with TCA (sodium trichloroacetate) and MCP (2 methyl, 4 chlorophenoxyacetic acid) makes flax potentially one of the most weed-free crops.

Technical nature of chemical control

Research at a number of experiment stations has emphasized the need for know-how and caution when using chemicals in agriculture. Under favorable weather conditions the West Virginia station was successful in using preemergence applications of dinitro and 2,4-D. It also learned, however, that using this chemical on sandy soil and under conditions of heavy rainfall reduced the stand of corn.

Combined fertilizer-weedicide spray

The North Carolina station successfully combined nitrogen, a detergent, and 2,4-D in a spray solution for use on corn as a fertilizer and weed killer. The spray should be applied toward the base of the stalk when the corn is about knee high, but the weeds must be small in size in relation to the corn. For early weed control, cultivation or pre-emergence sprays are recommended. As a top-dressing fertilizer, the spray is effective enough to warrant the extra cost of 50 cents per acre for adding the 2,4-D and the wetting agent to the nitrogen solution.

Chemicals for soybeans

2,4-D type chemicals are unsafe for weeding soybean fields, the Virginia station found, since these materials cause appreciable injury to the crop. For controlling weeds in this crop, the station recommends PCP (sodium pentachlorophenate) applied at the rate of 20 pounds per acre, or dinitro at 2 gallons per acre applied immediately after planting. The Missouri station made savings of $5 or more per acre through use of PCP or dinitro which brought about reduced labor costs and increased yields of soybeans.

2,4-D controls weeds in oats

Applications of 2,4-D by the Wyoming station to certain oat varieties at three stages of growth were effective in controlling weeds without significant reduction in oat yield.

In Horticultural Crops

Keeping asparagus weed-free

Michigan station experiments proved that CMU applied at the rate of 2 pounds per acre is superior to other chemicals for weed control in asparagus. The CMU is applied as a spray after the field is disked in early spring; if there is no further stirring of the soil, the herbicide will prevent weed emergence. Similar findings were reported by the Delaware, Massachusetts, and Pennsylvania stations.

Weedicide for lima beans

IPC at 1-1/2 gallons per acre or Oktone at 1/4 gallon per acre in Stoddard Solvent increased yields and gave excellent weed control in lima beans at the Pennsylvania station.

Herbicides for specific crops

Stoddard Solvent sprays followed by kerosene proved effective and selective for controlling major weeds in the Cape Cod cranberry bogs, the Massachusetts station reports.

To date, the most promising chemical used for weed control in spinach is CIPC, according to the Pennsylvania station. This station, as well as Delaware and other stations,

found the new herbicide Natrin (2,4,5,-trichlorophenoxyethyl sulfate) promising for tomatoes. The Delaware, Oklahoma, Ohio, and other stations reported good weed control in strawberries with 2,4-D or Crag 1 at 1-1/2 to 2 pounds per acre. The amine salt of dinitro was safer for preemergence weed control in sweet corn and potatoes than any other material tested to date at the Maine station. Emergence is the optimum time for application on corn.

Weeding blueberries doubles yields

In New Hampshire, many blueberry areas in production for 40 to 50 years have decreased in yield and become overgrown with weeds until abandonment became necessary. Earlier attempts to fertilize these fields to increase blueberry production were futile because the fertilizer so stimulated the weed plants that they suppressed and crowded out the berries. Labor costs for continuous cutting of these weeds were prohibitive. The New Hampshire station has shown that use of chemical herbicides, mainly 2,4-D and 2,4,5-T, for killing the weeds and brush makes it feasible to treat blueberry areas. In many cases the yield and increased vegetative growth of the blueberry bushes have been doubled. Additional fuel, such as oil or hay, has not been needed for burning. This has stimulated new interest in growing low-bush blueberries in New Hampshire.

Annual weed control in citrus orchards

In seeking methods for reducing the high initial cost of nontillage weed management in citrus orchards, the California station showed that CMU, when applied to the soil in the fall at rates of 1 to 4 pounds per acre, will control weeds through the winter rainy season. Rates of as much as 40 pounds of CMU commercial formulation per acre in orchards caused no symptoms of injury to orange and grapefruit trees.

BRUSH CONTROL

Chemical brush control

Most native woody plants sprout if their tops are cut off. New chemical control methods reduce the amount of labor and ultimate cost of woody plant control in pastures, rights-of-way, and other noncultivated areas by reducing the amount of sprouting. In the woodlot or forest, chemical methods may be used to kill objectionable trees to make room for desirable species. Aircraft application of 2,4-D and 2,4,5-T by the California station proved particularly effective on brush sprouts and seedlings coming up after a burn. Studies by the Oklahoma station have shown that worthless post oak and blackjack type of brushland can be converted economically to valuable grassland by airplane spraying with 2,4-D and 2,4,5-T. The best time to spray is when the plants have just developed full-size leaves. Texas, Colorado, and other western stations have demonstrated that thousands of acres of sagebrush range can be profitably restored to greater forage production by the use of these herbicides.

Experiments by the Montana station showed that leafy spurge can be controlled with a combination spray of ammonium sulfate and 2,4-D. Recent findings by the New York (Cornell) station were that a dormant basal spray of 5 percent 2,4,5-T in kerosene is effective on beech, aspen, and thornapple.

BOTANY AND PLANT PATHOLOGY

Irradiated algae lose chlorophyll

By irradiating the green alga, Chlorella, with ultraviolet light, the Minnesota station duplicated evolutionary changes that occur in nature. Cells of the green alga subjected to ultraviolet light produced colorless mutants lacking the green pigment chlorophyll. The new forms thus obtained were similar to micro-organisms found in nature and described

as fungi. The experimental changes apparently reproduced those that occurred in the origin of the colorless species in nature. Further studies of this nature may reveal the origin of parasitism in micro-organisms.

Diseases of Field Crops

Cereal diseases

The wheat streak mosaic virus was found to be transmitted from plant to plant by a mite, Aceria tulipae, two years ago. This did not account, however, for the rapid spread of the virus from one field to another. In studies by the Nebraska station in Kimball and Lincoln counties, where some wheatfields were completely destroyed by the wheat streak mosaic, it was discovered that the mite was wind-borne from field to field throughout the fall and winter months when plants are small and readily infected. Volunteer wheat serves as a bridge to carry the mite from crop harvest in the spring to crop planting in the fall. It was also found that the mite had difficulty in establishing itself on native wild grasses so that they may not play so important a part in the spread of the disease as first expected. Eliminating volunteer wheat, and planting the fall crop as late as feasible are proving effective control measures.

Rust resistance changes under different temperatures

Minnesota station research (coop. USDA) emphasized the need for testing new wheat variety seedlings for stem rust resistance both at high and low temperatures. Wheats resistant to certain races of rust at 60° F. were completely susceptible above 90°. Among many composite factors responsible for determining resistance to certain races of rust, some resistance factors are effective at both low and high temperatures, whereas others are effective only at low temperatures. The Iowa station (coop. USDA) found a similar situation with crown rust of oats. The oat varieties Santa Fe, Bondvic, Clintafe, and Clintland were uniformly highly resistant at both 59° and 77° at all stages of growth. The variety Landhafer was highly resistant at 59°, but at 77° this resistance broke down sufficiently at all stages to differentiate it clearly from the other highly resistant varieties. The Missouri variety 0-205, completely susceptible in the seedling stage, showed a high degree of adult plant resistance at both temperatures.

How new rust races originate

The Minnesota station has demonstrated that new races of stem rust, known to originate in the common barberry, can also originate in the wheat plant itself. Experimental inoculations resulted in new races that were more virulent than the parental types, and differed also in spore color.

Grain damage in storage

The Kansas station observed that with constant temperatures of 86°, 104°, and 122° F., and at moisture contents varying from 14 to 20 percent, the onset of browning in fresh unprocessed wheat germ was related to temperature and moisture content and preceded mold growth. Browning of the germ was characterized by a fall in pH and by a decrease in protein peptizable by potassium sulfate. The results further indicate that sugar protein condensation in the germ is the basic cause of the browning discoloration of sick wheat. Storage fungi play a secondary role in promoting this deterioration by providing the elevated temperatures and humidities favorable to the non-biological browning mechanism.

At moisture contents of 13.5 to 14.5 percent, the Minnesota station learned that wheat kernels were invaded by a slow growing strain of mold, Aspergillus glaucus, which requires special techniques to detect. Once the seed is heavily attacked by storage molds, it is more susceptible to later deterioration than grain that is low in mold count. Results of the research emphasize the need for extensive sampling of commercial bulk storage of grain for moisture range fluctuation.

Seed protectants

In experiments at the Indiana station (coop. USDA), captan, Arasan SFX, Phygon, and thiram were found generally superior to other materials in protecting corn seed from invasion by parasitic soil-borne fungi as determined by germination of the seed lots following the cold test. Sound seed germinated better than injured seed, but captan appeared to give somewhat better protection to the injured seed, although this relationship was not evident in the case of sound seed. The Iowa station obtained an average increase of 10.2 bushels of corn per acre using eight seed treatment materials. The Arasan SFX treatments gave increases of 8.6 bushels per acre, whereas two captan treatments averaged 15 bushels per acre increase. Flaxseed treated with Ceresan M and captan increased yields 2.4 bushels per acre. When oatseed was treated with captan, the yield was increased from 3 to 5 bushels per acre depending upon the amount of the fungicide applied to the seed. The captan seed treatment was outstanding in increasing stands of alfalfa.

Bluegrass and fescue seed treated with Arasan by the Pennsylvania station gave increases in stand ranging from 16 to 22 percent. Seed treatment did not, however, increase stands of bentgrass. Experiments with the Tersan soil drench 1 to 2 days prior to sowing bluegrass gave 37.4 percent increase with untreated seed and 47.2 percent with Arasan-treated seed.

Recent studies by the Colorado station with improved chemicals for control of seed rot and seedling blight of sugar beets indicated that Manzate at 12 ounces per 100 pounds of seed increased stands 32 percent. This has a potential annual value to Colorado growers of over half a million dollars.

Vegetable and Fruit Diseases

Bacterial canker of tomato caused by Corynebacterium michiganense can be effectively controlled by direct field seeding, according to the California station. The plant bed-to-field transplant method widely used by growers infects more than 50 percent of the tomato plants, whereas the new method of direct field seeding never produces more than a trace of canker.

The California station showed that by dipping the freshly cut basal end of sweet-potato sprouts, first in a spore suspension of the fusarium sprout rot organism, and after an interval, in a spore suspension of the fusarium wilt organism, the limited basal rot caused by the sprout rot fusarium will protect the plant against subsequent invasion by the wilt Fusarium. Promising results were obtained both in greenhouse and field tests.

Gray mold which causes a decay of strawberries has always been a difficult fungus to control, but experiments at the Illinois station show that captan is effective in increasing production from 107 to 193 crates per acre. Berry size was increased so that it took only 92 berries to fill a quart box instead of 123.

Antibiotics in Disease Control

For over two hundred years, fireblight of apples and pears has caused widespread damage to fruit trees. Growers of the susceptible apple varieties Jonathan, York, Imperial, Wealthy, and Yellow Transparent frequently reported loss of an entire crop. This disease also was primarily responsible for the destruction of commercial pear culture in central and eastern States. In 1951, the Missouri station demonstrated that antibiotic sprays could reduce the severity of fireblight. In 1952 and 1953, laboratory, greenhouse, and extensive field experiments showed that streptomycin and terramycin gave excellent control. Streptomycin at concentrations as low as 100 p. p. m. applied in a series of sprays during bloom and past-bloom periods provided complete control. When the fireblight bacterium was administered artificially to greenhouse plants they required higher concentrations to effect complete control than did naturally infected trees in the orchard.

Streptomycin and terramycin were found by the Ohio station to inhibit the fireblight bacterium at concentrations as low as 1 p. p. m. Orchard experiments involving use of foliage sprays at 120 p. p. m. gave nearly 100-percent control of fireblight when applied three times--twice when the trees were in bloom, and once at petal fall. Even at 60 p. p. m., fair control was obtained. Terramycin appeared to be slightly less effective.

Pear blossoms inoculated by the New York State station with the fireblight organism, were sprayed with streptomycin (30 percent active) at 120 p. p. m., thiolutin (48 percent active) at 100 and 60 p. p. m., and the standard bordeaux 2-6-100. There was only 10 percent blight with the streptomycin, 31 to 35 percent with the thiolutin, whereas 87 percent blight occurred with bordeaux. The unsprayed trees had 80 percent blight.

Applications of a dust composed of bentonite impregnated with 240 p. p. m. of streptomycin to pear trees in full bloom controlled fireblight infection and caused none of the objectionable fruit russeting often produced by other compounds, according to a report by the California station. It was also found that streptomycin sprays at 10 p. p. m. controlled walnut blight.

Seed piece decay and blackleg were eliminated and ring rot infection reduced on potato seed pieces treated in 25 p. p. m. streptomycin sulfate solution at the Maine station experiments. The late blight fungus was also inhibited by setting cut potato stems in 100 p. p. m. terramycin hydrochloride for 72 hours. All the above studies point to practical and efficient ways of controlling many plant diseases by the use of antibiotics.

In a commercial planting of tomatoes sprayed with agrimycin, an agricultural formulation containing streptomycin and terramycin, the Florida station found that it gave outstanding control of bacterial spot on the seedlings caused by the bacterium Xanthomonas vesicatoria. Ninety-five percent of the sprayed plants were usable, whereas only 27 percent of the untreated plants could be saved for planting.

Production of antibiotics in the soil and the influence of such substances on soil micro-organisms is under study at the New Jersey station. It was established that bacterial wilt of the chrysanthemum can be controlled with streptomycin which is absorbed and translocated by either cuttings or rooted plants. Protection against the disease persisted for several weeks.

Before antibiotics are widely adapted in disease control, a great deal more research will be needed to determine their phytotoxicity, compatibility with other fungicides and insecticides, safety, costs and ease of applications, as well as disease control potential under various climatic conditions. There is urgent need for basic research on the mode of action of antibiotics; that is, by what mechanism do these substances suppress or prevent the development of organisms that cause plant diseases.

Nematode Research

During the past year, regional research was undertaken whereby 13 of the Southern States, Puerto Rico, and the Department of Agriculture will investigate the diseases and disease complexes caused by plant parasitic nematodes. It is now becoming recognized that nematodes probably cause more extensive losses to crops in the Southern States than any other group of plant diseases. In this region practically every crop is subject to attack by nematodes. These minute parasitic worms are concentrated in the root zone, indicating a dependence on roots as a primary habitat and source of food.

The Kentucky station established a relationship between spring sowing of alfalfa and nematode frequency. Over 100,000 meadow nematodes and eggs per gram were obtained from the roots of a spring sown alfalfa field that had failed. However, after the field was summer fallowed and reseeded in the fall, only 1/1000 as many nematodes per gram were obtained and a good stand of alfalfa was secured.

Surveys of problem fields in North Carolina showed that 12 genera of plant parasitic nematodes were involved. The root knot, meadow, tobacco stunt, and the sting nematodes, representing 4 distinct groups, accounted for about 75 percent of the crop losses.

Fallowing soil during May and June during periods of extreme heat and drought was the most effective method of reducing nematodes in the soil previous to planting lima beans, according to an Oklahoma station report. At the Delaware station, root-knot nematode was markedly reduced after fallowing the soil in May and June, resulting in a 50-percent increase in tomato yield.

Research on nematodes has also been expanded in California and Oregon where a decline in growth of many crops has been observed. In California, profits from increased yields of cotton and tomatoes were far in excess of the cost of the preplanting row fumigation undertaken by the station. Nematicides also gave excellent results as an aid to establishing vines in root knot nematode infested vineyards.

Fusarium wilt of cotton, commonly known as wilt, is a disease of great economic importance throughout the Cotton Belt. A recent discovery by the South Carolina station (coop. USDA) revealed that wilt is worse where sting nematodes wound the cotton roots, furnishing an avenue of entrance for the wilt fungus. Cotton varieties not resistant to wilt had little of the disease when the sting nematode was not present.

Tree Diseases

Oak wilt not spread on dried lumber

Thousands of specimens of wood products were examined for the oak wilt fungus by the Ohio station and in no case was the live fungus found. Even in slabs and large limbs from trees killed by the oak wilt fungus, the organism has not been isolated after the moisture content of the various parts was reduced below 60 percent. Results of a 2-year study indicate that with the ordinary precaution of drying lumber and wood products, there is no chance of spreading the disease to foreign countries through shipments of lumber. In no case has the oak wilt fungus been obtained from air-dried wood products.

A new technique developed by the Missouri station (coop. USDA) for isolating the oak wilt fungus which involves the use of water agar provides a reliable and rapid means of confirming oak wilt. The short survival period of the fungus in small-diameter material at relatively high temperatures points up the importance of careful handling of suspect material to be used for confirming oak wilt by laboratory isolation of the organism.

New technique for Dutch elm disease control

A simple method of application and a new chemical specific for mitigating Dutch elm disease damage have been developed by the Rhode Island station. A spiral arrangement of holes was tangentially bored in the tree trunk. The chemical is made into a paste with water and dispensed into the holes by means of a caulking gun. A cork closes the opening which is then sealed with a grease. The rate of uptake is dependent upon the amount of moisture available to the roots. Both artificially and naturally infected elm trees have been protected and cured of Graphium ulmi, the fungus causing the disease, by such medication introduced directly into the sap stream.

Suppression of Dutch elm disease symptoms and probable control of the disease by trunk injection with lauryl pyridinium chloride were reported by the New Jersey station. Persistent efforts may yield a substance that will more effectively control this destructive disease.

Plastic bags reduce maple sap contamination

Maple saps collected in plastic containers are freer from bacterial contamination, the Vermont station proved. Galvanized, aluminum, plastic, and wooden buckets were hung at the four compass points on trees. Sap temperatures were recorded by micromax throughout the season, and micro-organism populations were determined every week. Temperatures were higher in plastic bags but numbers of micro-organisms were always lower

than in other kinds of buckets. All buckets other than plastic were highly contaminated regardless of position on the tree. At the end of the season when contamination was extremely high in conventional buckets, no organisms were present in plastic bags. Experiments are under way to determine why organisms do not live in maple sap collected in plastic bags.

Keeping evergreen seedlings healthy

A few years ago a little-known fungus disease almost wiped out the production of white pine and Douglas fir seedlings in Delaware. Then the Delaware station developed a treatment which now provides a record production of seedlings. Using a combined treatment of soil fumigation and foliage spray, a double-barreled method was found for protecting conifer seedlings from the time of germination until the seedlings leave the plant bed 2 to 4 years later. The treatment has also increased the growth rate of young evergreens. Being free of parasites, the white pine and Douglas fir seedlings grow as rapidly in 2 years as they did formerly in 3 or 4 years. Although the fungus, Cylindrocladium scoparium, attacks northern conifers such as white and red pine, it does not harm southern conifers such as loblolly pine.

Bacteria Assimilate Carbon Dioxide

Studies at the Iowa station showed that heterotrophic forms of life (those that do not manufacture their own food) assimilate carbon dioxide, the process being similar to that taking place in photosynthesis. Through the use of radioactive carbon, C^{13} and C^{14}, it was demonstrated that assimilated carbon dioxide was used not only to form carbohydrates and acids but also in the formation of amino acids. Assimilated $C^{14}O_2$ was found to be used to form leucine, valine, methionine, proline, glutamic acid, glutamine, citrulline, threonine, cysteine, ornithine, histidine, aspartic acid, tyrosine, and probably arginine--all amino acids probably essential in life processes.

Freezing Micro-organisms

Bacteria and viruses are being quick-frozen to -300° F. by the Wisconsin station to simplify the use of the electron microscope in studies of microscopic organisms. Materials must be dried before they can be examined with the electron microscope because the viewing chamber is under a high vacuum. Ordinary air-drying or heat-drying distorts the shape of testing particles. By the new technique, very tiny droplets of the bacteria or virus are sprayed onto blocks held at -300°. The droplets freeze as soon as they strike the surface. The blocks are then put into a vacuum chamber which dries away the ice surrounding the specimen and prepares it for study under the electron microscope. This technique should lead to more precise studies of related organisms, as shown by the tobacco mosaic virus previously thought to be rod-shaped, but now shown to have a hexagonal shape in cross-section.

CONTROL OF DESTRUCTIVE INSECTS

Protecting Growing Grain

Armyworm control saves one-fourth of grain crop

Missouri station research on insects has been directed largely toward service to Missouri farmers in pest control. During one year armyworms invaded the entire State, but they were most severe in the southern two-thirds. In this area it was safely estimated that armyworms reduced grain yields (wheat, barley, oats) by 25 percent where the fields were not treated. Some 7-1/2 million acres of grain crops and pastures were sprayed at a cost of $2 per acre. With a conservative estimate of 30 bushels per acre yield of grain and a $2-per-bushel value for the grain protected by destroying the insect, the recommended practice of spraying for armyworm control produced an estimated saving to the farmers of the State of $97,500,000 in a single year. Also, the new methods of chemical control are easy to apply and save money in labor required for application.

Insecticides reduce damage to corn by insects

Losses from 10 to 100 percent in cornfields infested by corn rootworms were greatly reduced in Kansas station experiments by aldrin, heptachlor, or chlordane applied in a band at planting time. Injury to pollination by corn rootworm beetles which cause losses of thousands of bushels of corn, was avoided by spraying with DDT shortly after first silks appear. Almost 100-percent control was obtained. The practices have been applied to thousands of acres of corn in Kansas.

Systemic insecticide may repel grain aphids

Research at the Oklahoma station on a systemic insecticide tagged with P^{32} suggests that repellency may be an important factor in ridding fields of insect pests. Demeton applied to cereal seedlings through the root system caused aphids to leave the plants within a few minutes and to starve to death (or dessicate) without returning to the plants. Furthermore, the insecticide transpired from the leaves condensed upon other plants some distance away in quantities sufficient to kill aphids within about 6 hours after application of the tagged substance to the roots of the test plants.

Soil Insecticides

New insecticides stop soil pests

Soil pests that have waxed fat in Oregon feeding on plant roots and underground vegetables while costing the State thousands of dollars in annual income may be reaching the end of the road as "free boarders." Oregon station research has shown that 2 pounds of either aldrin or heptachlor to the acre mixed into the soil gave effective control of wireworms, larvae of western spotted cucumber beetle and tuber flea beetle, and seed-corn maggots in fields planted to potatoes and sweet corn. Sweet corn, a 2-1/2 million dollar crop in the State, and potatoes that averaged $17 million in value to Oregon during the past 2 years are the first in a series of crops scheduled to benefit by this pest control research.

Seed treatment controls soil insects injurious to corn

Research of the Louisiana station has shown that treating sweet corn seed with chlordane-thiram mixtures increased the yield from 945 dozen ears in untreated plots to 1,350 dozen ears per acre in treated plots. In two other tests on corn, using the same treatment, the yields were increased from 15 to 24 bushels per acre in one test and from 18 to 30 bushels per acre in the other test. The materials to treat seed for 1 acre cost approximately 10 cents.

Vegetable crops uninjured by accumulated toxaphene in soil

Accumulations of toxaphene in soil, due to repeated applications for insect control, apparently will not injure vegetable crops where total applications do not exceed 5 pounds per acre annually, Oklahoma station workers report. Beyond this level, injury to some vegetable crops can be expected. Research now under way is aimed at determining effect of toxaphene accumulations on organisms in the soil.

More Forage Seed and Feed

Insect control increases alfalfa seed crop

Insect control treatments were applied in early bud and full-bloom stages of alfalfa by the Indiana station. Earliness of application was important. Twice as many racemes developed per stem when a single late spray was applied at full bloom, five times as many in the bud stage, and ninefold when applied early during the first 2 to 4 inches of growth. The increase in seed yield by using three treatments a year instead of one was 38 pounds per acre. This additional seed production would not only pay for the cost of the extra treatments but would increase profits by $6 to $8 per acre.

Insect control increases bluegrass seed crop

Research at the Kentucky station revealed that heavy losses in bluegrass seed production were caused by plant bugs feeding on the developing seed. The major pests were the meadow plant bug and Amblytyles nasutus. DDT was found to give good control of these insects. Aldrin and lindane were found to be even more effective at low concentrations. Controlling these insects has resulted in profits of as much as $100 per acre.

Beetles control range weeds

Research of the Idaho station has found that planted colony of goatweed beetles, mainly Chrysolina gemellata, would control goatweed on 1 acre of heavily infected range in 3 years and on 10, 200, and 1,000 acres in 4, 5, and 6 years, respectively, under favorable conditions in the lower valleys of the Clearwater, Snake, and Salmon Rivers. Complete removal of the goatweed has not been obtained, even with the oldest colonies, although 90- to 95-percent control has been obtained. After the goatweed is controlled, good range management is required to prevent other weeds from spreading in some areas.

Insecticides raise alfalfa hay yields

Increased alfalfa hay yields of 108 percent and 143 percent resulted when methoxychlor and parathion, respectively, were applied for insect control in research by the Wisconsin station. Vitamin A was generally increased and protein was increased in some of the treated hay. Parathion is very poisonous and caution is necessary in handling it.

Crawfish damage on farmland controlled with DDT

The prairie crawfish infests certain upland soils in an area of Mississippi and Alabama known as the "prairie." The heaviest infested land may have as many as 20,000 burrows per acre, but the usual infestation will be 8,000 to 15,000 per acre. The feeding of these pests reduces forage production on pastures and hayland and makes the establishment of improved pastures difficult. Where numerous burrows occur on land used for row crops, it reduces the stand and may even completely destroy early plantings. The research of the Mississippi station has shown that DDT baits or sprays are an economical and effective control.

Disease Carriers Checked

Flea bettle control--a preventive of Stewart's disease in sweet corn

The New York State station in its research on the control of this disease studied two fields of sweet corn that had been sprayed with DDT to control flea beetles (carriers of Stewart's disease) and three unsprayed fields. The sprayed fields were lightly infected with the disease and yielded 200 to 240 bags (10,000 and 12,000 ears) of good corn per acre. The unsprayed fields were heavily infected with the disease and yielded about 20, 60, and 117 bags, respectively, of inferior corn.

Parathion reduces damage from virus diseases of peas

In research on the control of insect carriers of plant diseases, the New York State station found that in three plantings of peas three parathion sprays reduced the relatively low incidence of pea virus disease from 13 to 3 percent, from 29 to 8 percent, and from 22 to 10 percent. The treatments produced increase in yields of 108, 324, and 180 pounds of peas per acre, respectively. Where the incidence of disease was lowest, the value of the increase in yield did not equal the cost of treatment. Where the incidence was higher, the value of the increase in yield was 2.7 and 1.2 times the cost of treatment. This showed a good profit when the incidence of disease in the untreated area was 29 percent and some profit at 22 percent. Parathion is very poisonous and caution is necessary in handling it.

Repellents for carriers of the cattle disease--anaplasmosis

Repellents, rather than acaricides, may answer the problem of preventing ticks from spreading the serious livestock disease, anaplasmosis, research at the Oklahoma station suggests. No known acaricide kills ticks quickly enough to cause death before an infected tick has time to bite and thereby infect the animal. Infection in ticks is carried through the egg. After testing some 800 chemicals for possible repellency, 4 have been found which repelled ticks up to 3 weeks under laboratory conditions.

Improved Control Methods

Better Lygus bug control on cotton

When alfalfa seed was allowed to mature for seed in early July, Lygus bug transfer to cotton resulted in more severe damage than when a seed crop was matured later, the Texas station reports. Yields in cotton under observation were reduced more than 75 percent by Lygus bugs. Toxaphene dust was effective in controlling these insects on cotton. Three applications at a total cost of $7 per acre resulted in an increase in yield of 483 pounds of lint per acre over untreated cotton, or a total gain of $154.64 per acre.

Device detects termites by "eavesdropping"

A compact, electric, sound-detection unit which locates termites by the unique noises they make has been developed by the California station. The instrument consists of a tiny microphone, "hip-pocket" power unit, and earphones. Its compactness is especially suited for working in the tiny nooks and crannies which must be probed to discover termite infestations. It may eliminate destructive bore-and-chisel methods now necessary to detect the presence of termites.

Peach tree borer control made better and easier

Three trunk sprays of parathion applied to peach trees at monthly intervals starting August 1 resulted in effective control of peach tree borers in Georgia peach orchards. Experimental peach trees, 3 and 6 years old, have never been injured by borers from the time they were set in the orchard. One tree out of 41 in the 11-year-old group showed borer injury. In the 18-year-old group, 43 trees out of 50 were free of borers. The 7 infested trees had been mechanically injured in the past. The Georgia station points out that this method of control requires less labor than the old mounding methods and kills the borers before they have had time to injure the trees. Parathion is very poisonous and caution is necessary in handling it.

New wasp control aids citrus harvest

To protect the workers in citrus groves from being stung by wasps, the Arizona station found that thanite in a spray base oil applied to the wasp nests was an effective and economical control. The spray produced no plant injury, and developing larvae perished after the adult wasps were killed by insecticides. Adequate protection for workers in citrus groves was obtained by spraying the wasp nests during late June, followed by a second treatment about 6 weeks later.

Light controls mites in stored cured hams

Mites identified as Tyrophagus lintneri (Osb.) have inflicted heavy losses in stored cured meats. The North Carolina station discovered through research that natural or artificial light directed on the meat prevented infestation by this mite or eliminated it from the meat surface. The rate of elimination was dependent upon light intensity. Wavelengths above the ultraviolet range were necessary.

Sugarcane borer control

The broad, diversified research program of the Louisiana station (coop. USDA) on sugarcane borer control, embracing biological, cultural, and chemical control practices, has resulted in the development of several methods of reducing the damage from this pest.

Shredding of cane tops and chopping and "wrapping" (covering with soil in middle of row) of cane overwintering material to reduce the number of overwintering borers, the release of 60 million Trichogramma egg parasites to help control later generations of borer, and dusting of about 70,000 acres of cane and corn with cryolite or ryania resulted in an increase of 4 to 5 tons of cane per acre on many cane farms in the State.

Improved control of insect pests of trees and shrubs

Since 1948 the research of the Rhode Island station has improved control methods for more than a score of the most destructive insects of ornamental and forest trees and shrubs, such as the rhododendron whitefly and lace bug, the willow sawfly and flea weevil, and the red-headed pine sawfly to mention only a few. In addition to solving control problems, much valuable information on the habits and activities of the insects has been obtained which is needed for efficient control. DDT, methoxychlor, lindane, and nicotine sulfate have been found to possess the greatest versatility in controlling these pests. A conservative estimate of the value of these improved controls indicates they are worth at least $100,000 annually to nurserymen, arborists, homeowners, and others.

DDT resistance in flies

The research of the Wisconsin station on what makes insects resistant to DDT has shown that there was little difference between resistant strains of fruit flies that had been exposed and selected for resistance to DDT and flies that were resistant three years ago but had not come in contact with the insecticide since then. This research also indicated that fruit flies that are resistant to DDT probably carry genes or factors for resistance on every chromosome.

Two gallons of spray per acre controls insect pests on cotton

The Texas station has found that 2 gallons of spray per acre controlled cotton insect pests as well as 6 or 14 gallons, as measured by both yields and insect infestation, provided an equal amount of active insecticide ingredient was applied to all test plots. Because of the time and labor saved in handling a smaller quantity of water, spraying at the lighter rate resulted in substantial savings.

Thrip control increases onion yield

In research of the Louisiana station the average increase in yield of onions as a result of thrips control with DDT was 1,586 pounds per acre.

POULTRY RESEARCH

Improvement Through Breeding

Crossbred poultry for packaging

Poultrymen selling cut-up poultry to the package trade can profit by crossing breeds of chickens. The Arkansas station demonstrated that on the basis of retail price differentials for cut-up chickens, the average crossbred carcass gave a 12 percent higher retail price than the average purebred carcass. Although no significant difference was apparent in growth rate or carcass yield among the crossbreds or among purebreds, considerable difference existed between the average live weight of the two groups.

The White Olympian chicken

A new breed of chicken, White Olympian, which is dominant white, moderately broad-breasted, and fast-feathering has been developed by the Washington station. The hens run very true to type. The flock averages a 60 percent rate of egg production and 80 percent hatchability of all eggs set. White Olympian eggs are off-white to cream colored, and average well above the weight requirement for Grade A large eggs. The fryers have no pinfeathers and dress out clean. When the White Olympian is crossed with a New Hampshire or a Rhode Island Red male, the cockerels are pure white, whereas the females carry a little red color, a difference that permits sexing of chicks with 99 percent accuracy.

Chickens that cannot fly

The Maryland station is developing a breed of chicken that cannot fly. After the first molt, the long pinion feathers do not grow back. The original male parent, a New Hampshire Red mutation became the sire of the flightless flock of New Hampshires, now maintained by the station for breeding experiments. Some crossings have been made with White Leghorns, the backcrossings from which resulted in desirable broilers with white plumage plus the flightless characteristic. Although the birds are not clumsy, they are not as agile as normal chickens. Their nests must either be close to the floor or have a ramp.

A new white turkey

Empire White is the name given to a new strain of turkeys developed by the New York (Cornell) station. This strain is considered better in meat quality than the White Holland and superior in productive ability to the Broad-Breasted Bronze even though about the same size. Averaging 7-1/4 inches across the breast, the Empire White doubles the minimum breast width standards established by the U. S. Turkey Improvement Plan.

Physiology of Poultry

Hen has automatic assembly line

Nerves located between the egg duct and the pituitary gland in the laying hen are nature's device for timing egg delivery, according to Illinois station scientists who are studying the egg-laying process. These specialized nerves synchronize release of yolk from the ovary, the addition of egg albumen and shell, and the laying of the egg. The pituitary gland secretes the hormones which make possible maturation of yolks in the ovary and their release. When a yolk is present, the duct awaiting albumen formation stimulates nerves which signal the pituitary gland that no more yolk should be released. Thus inhibited, the gland waits until the egg has moved out of the region where the nerves are located and egg white is formed before it secretes the hormone necessary for the release of another yolk from the ovary. Thus an orderly sequence of egg laying is possible.

Artificial turkey breeding

In experiments carried on over a 7-year period, the Oregon station was able to improve fertility of turkey eggs by at least 15 percent through substituting artificial insemination for natural matings. The optimum semen volume used was 0.03 cubic centimeter, and insemination of the hens took place at 3-week intervals. Fertility was 86 percent immediately after collection from the tom, but percentage dropped 10 to 20 percent when the semen was held at 55° F. for 1 to 4 hours following collection.

Hormone balance and egg production

Artificial control of egg laying through the use of hormones may become a practical solution for getting hens to molt when prices are low or to increase egg production when

prices are high. The Maryland station found that progesterone, a female sex hormone usually associated with mammals, will cause laying hens to molt and grow new feathers. Similar experiments conducted by the New Jersey station with the drug Enheptin, which inhibits reproduction by suppressing essential hormones, forced laying hens into a complete molt with eventual cessation of egg production. Further tests are necessary, however.

Ultraviolet irradiation benefits chicks

The Storrs station (Connecticut) reports that baby chicks were benefited after 8-weeks' continuous exposure to germicidal ultraviolet energy from lamps with a maximum output of 2,537 units and noticeable ozone production. The body weights and breast angle of the treated birds were larger than those of the untreated ones. Mortality was slightly reduced in treated pens. Chicks irradiated continuously with germicidal ultraviolet and fed a diet without added penicillin equaled the growth of chicks fed diets supplemented with the antibiotic. Both lots were superior to control groups which received either the irradiation or antibiotic treatment. When both variables were applied to the same birds, the effects appeared to be additive, suggesting that the two treatments do not act in the same manner.

Feeding for Profit

Phosphorus and iodine requirements

The Wisconsin station has shown that a ration containing 0.43 percent of phosphorus supports production as well as 0.75 percent, the amount previously recommended by the National Research Council. Similarly, the Indiana station sought new information on iodine requirements. National Research Council recommended levels were from 660 to 1,100 parts per billion. The Indiana station found that although a diet containing only 50 parts per billion of iodine or less would not support normal growth, 75 parts per billion sufficed to support growth up to 8 weeks. The amount required for normal thyroid glands, however, was considerably higher, as slight abnormalities were noted when the level fell below 300 parts per billion. Levels as high as 4,800 parts per billion were not toxic.

Unidentified factors for reproduction

The Arkansas station using White Wyandotte hens in the experiments, found an unidentified forage juice factor necessary for reproduction. When 3 percent of a forage juice concentrate was added to a diet containing all known factors required by breeding hens, a significant reduction in the number of "infertile" eggs occurred. In addition, the number of salable chicks increased about 8 percent.

A factor present in liver, fish solubles, fish meal, and certain types of fermentation products, according to the Texas station, is required for better hatchability of eggs. Hatchability of eggs from hens deficient in this factor may be increased from 25 to 85 percent in 2 weeks. Likewise, the hatchability of turkey eggs has been improved from less than 10 percent to as much as 70 percent within the same length of time by adding liver to an all-vegetable diet containing an adequate quantity of known nutrients.

Unidentified growth factors

At least three different unidentified nutrients are required for rapid growth of chicks and poults, according to the Maryland station, namely the "liver," "whey," and "alfalfa" factors. Most of the crude products tested appear to contain measurable quantities of more than one of these factors. The Texas station found that the growth factor in fish solubles differed from the "whey factor." The Texas station also improved chick growth by feeding autoclaved litter suspension with either fish solubles or an antibiotic combination, indicating the presence of an unidentified factor in autoclaved litter.

Inedible fats for broiler rations

How much and what kinds of inedible fats can be used in broiler rations? Poultry scientists at the Ohio and Delaware stations state that the primary effect of such fat in the ration is to increase feed efficiency. This use of extra fat to replace a part of the cereals was confirmed by the Kansas station where broiler rations supplemented with 3 percent of added fats improved palatability and feed efficiency without a significant increase in growth. In a test of seven greases and two fatty acids at the Wisconsin station, only hydrogenated fat and stearic acid failed to improve feed utilization. In a broiler feed that contained 5 percent of added unstabilized fat which had been stored at approximately 80° F. for four weeks, the Maryland station reports failure to improve feed efficiency until an antioxidant was added.

Effects of restricted feeding

By putting 4-week-old chicks on a 75 percent restricted ration and continuing this ration for twenty weeks the Louisiana station saved seven pounds of feed for each pullet raised, but the onset of egg production was delayed for three weeks.

Chickens dislike birdsfoot trefoil

Preliminary results in a forage study at the Vermont station show that chickens dislike birdsfoot trefoil. Using a cafeteria-style technique, ten commonly grown forages were tested alone and in various mixtures. The birds picked at the trefoil plants and then dropped the leaves without eating them. The chickens preferred weeds to the trefoil, whereas they ate ladino clover and orchardgrass with relish. Since the Empire strain of trefoil was used, tests have been started to see if the European type and narrowleaf trefoils are more acceptable to the chickens.

Chick hemorrhage and nutrition

The California, Iowa, Wisconsin, and other experiment stations have recently linked the hemorrhaging of baby chicks, which has caused serious losses to some broiler flocks, to a deficiency of the nutrient vitamin K. The West Virginia station reports that its scientists have also observed an enlarged joint condition (virus arthritis) in commercial flocks suffering from the hemorrhagic syndrome. Studies are under way to determine any possible relationship between the enlarged joint condition and a respiratory disease which, in turn, may be related to the hemorrhagic condition.

Interrelationship of nutrients

Research by the Illinois and Washington stations on the vitamin niacin and the amino acid tryptophan points to a close relationship between the various nutrients. L-tryptophan can completely replace niacin, according to the Illinois station, but niacin does not spare tryptophan. The Washington station reports experiments in which the niacin requirement for chick growth was approximately 11.5 milligrams per pound in the presence of 0.13 percent of tryptophan, although it was only 7.7 milligrams per pound in the presence of 0.1 percent of additional tryptophan.

ANIMAL PRODUCTION RESEARCH

Beef Cattle

Inbred bulls tested in crosses

Hybrid vigor obtained by crossing inbred lines of beef cattle at the Colorado station (coop. USDA) has shown a beneficial effect on reproductive performance of cows as well as weight gains of their calves. Linecross matings had an 18-percent advantage in calving percentage, and the calves were 9 percent heavier at weaning compared with the parent

inbred lines. In feed-lot performance tests, linecross bulls gained faster and were superior in live grade at yearling age compared with inbred bulls.

At the Ohio station (coop. USDA), bulls from inbred lines developed by the Department in cooperation with the Montana and Nebrasks stations are being evaluated in comparison with non-inbred purebred bulls for improving production in commercial beef herds. First-year results show that the progeny of Montana line 1 bulls averaged 12 pounds heavier at weaning than those of outbred bulls, when mated with similar grade Hereford heifers. In a feeding trial, steer calves sired by the inbred bulls gained 2.42 pounds daily compared with 2.02 pounds for the progeny of outbred bulls, and consumed less feed per 100 pounds of gain with a saving of about 13 percent in total feed cost. Heifer progeny of the inbred bulls showed an advantage of 8 percent in daily gain, and 14 percent in feed efficiency. Progeny of the Nebraska line 1 bulls were superior to those of outbred bulls in daily gains, with a small advantage in feed efficiency.

Culling low-producing cows

Low-producing cows can be culled from the herd with reasonable accuracy on the basis of one or two calf crops, studies conducted by the Tennessee station (coop. USDA) showed, confirming last year's report by the Oklahoma station. The tendency for cows is to wean calves of similar weight and type in successive years. By adjusting weaning weights of the calves for the effects of important environmental factors, the accuracy of selecting breeding stock each year can be improved. In the Tennessee experiments cows reached maximum productivity at the age of 7 to 8 years. Differences in weaning weights of calves between 2- and 8-year-old cows were as much as 80 pounds.

Summer gains indicative of heat tolerance

The Texas station (coop. USDA) has been conducting heat-tolerance studies with beef cattle in an effort to find criteria that may be useful in the selection of breeding animals adapted to climatic conditions of the southern region. Although Brahman cattle had significantly lower rectal temperature, respiration rate, and pulse rate than Herefords under both field and controlled conditions, summer gains on pasture were similar for the two breeds. Crossbred progeny were intermediate between the parent breeds in rectal temperature and respiration rate, but they had a higher pulse rate and made greater summer gains. Estimates of the heritability of summer gains indicate that selection for this trait should be effective.

Breeding 2-year heifers

Breeding heifers to calve first at 2 years of age instead of the usual 3 years resulted in about one extra calf per cow at 5 years of age, with no additional feed cost, according to the Oklahoma station. Different levels of supplemental winter feeding or age at first calving had little effect on mature body weights of the cows or weaning weights of their calves, when the cows had access to an abundance of summer and winter pasture. A combination of early calving and low nutrition retarded somewhat the development of the cows, but those which calved first at 2 years averaged only 51 pounds lighter at 5-1/2 years than cows calving first at 3 years. Total feed and pasture costs for cows wintered at a high level were 80 percent greater, and those wintered at a medium level were 35 percent greater than costs for cows wintered at the low level.

Beef Animal Rations

Iowa stilbestrol trials

Yearling steers fed a small amount of stilbestrol daily with a fattening ration yielded an extra 0.83 pound of gain per day in a 112-day feeding test conducted by the Iowa station. Steers receiving the hormone gained 3.06 pounds daily compared with 2.23 pounds for the control lot fed the same ration without the hormone, and they made this gain on 20 percent less feed per pound of gain. The two lots of steers were comparable in carcass quality,

and no adverse effects were observed from feeding the hormone, as have frequently resulted in other experiment station trials when stilbestrol pellets were implanted under the skin of the animals.

Less feed with aureomycin

Aureomycin improved performance of beef cattle when fed with a high roughage ration but had no effect on growth rate or feed efficiency when fed with a fattening ration, Indiana station tests show. Yearling steers receiving 75 milligrams of aureomycin per animal daily, with a ration consisting of ground corncobs and a complex protein and mineral supplement, gained significantly faster than the controls in a 161-day feeding test. The aureomycin-fed steers required 18 percent less feed, and the feed cost was reduced 2 to 3 cents per pound of gain.

Trace minerals in rations

Feeding a trace mineral mixture to steers with a fattening ration of corn, soybean pellets, and prairie hay increased daily gains 23 percent over similar steers receiving no trace minerals, according to the Kansas station. The trace-mineral-fed steers had better appetites, utilized their feed more efficiently, and yielded higher grading carcasses, with a slightly greater return over feed costs, when compared with those in the control lot. In a wintering ration, trace minerals had no apparent beneficial effects.

Cellulose-digesting factor discovered

A number of the State experiment stations are investigating basic factors which influence the digestion of roughages, such as hay, by ruminants. The Ohio station found that valeric acid, one of the volatile short-chained fatty acids that occurs naturally in many plants, is apparently one of the important cellulose-digesting factors present in the rumen. In experiments with an artificial rumen, valeric acid increased digestion of cellulose material about 300 percent more than when it was not added. Certain other short-chained fatty acids, including isobutyric, isovaleric, and caproic, showed similar activity but to a lesser extent. This research will be extended to determine if the addition of small amounts of valeric acid to the ration of ruminants may have practical value in livestock feeding.

Cottonseed cake for fattening

Cottonseed cake fed at the rate of 1.5 pounds daily in a fattening ration for steer calves resulted in greater daily gains, higher selling price, and greater profits per steer than levels of 1 or 1/2 pound in a 5-year study by the Oklahoma station. Calves fed 1.5 pounds of cottonseed cake, with a ration of corn, sorghum silage, and alfalfa hay, made faster gains early in the fattening period and largely maintained this advantage throughout the trials.

Molasses aids feed utilization

At the Louisiana station blackstrap molasses and cottonseed hulls, fed in equal proportions to fattening steers with a supplement of cottonseed meal, dehydrated alfalfa meal, and extra phosphorus, resulted in better feed utilization, and significantly higher dressing percentages and carcass grades than steers fattened on rations containing less molasses. In general, feed consumption increased as the ration of molasses and cottonseed hulls was increased from a 1 : 10 ratio to a 10 : 10 ratio. The group of steers fed the 10 : 10 ration consumed as much as 14 gallons of molasses daily, with no ill effects.

Peanut hulls for roughage

Peanut hulls are produced in large quantities in the Southern States and have little market value. When used in fattening rations of beef heifers, by the Virginia station, satisfactory feed consumption and daily gains were obtained with rations in which peanut

hulls supplied half of the roughage content of the ration. The rations consisted of 40 percent roughage, 40 percent ear corn, 10 percent molasses, and 10 percent protein concentrate, ground together and self-fed. All animals graded choice at the end of a 126-day feeding trial.

Copper deficiency and sterility

A proper balance of essential minerals, including certain trace elements, is needed for satisfactory growth and reproduction in cattle and other farm animals. The Florida station reports that copper deficiency, accentuated by increased amounts of molybdenum, caused destruction of the germinal epithelium in bulls, and they became completely sterile. Under similar conditions, the estrus cycle of cows was interrupted, but supplemental feeding of a small amount of copper resulted in normal reproduction.

SWINE

Breeding and Reproduction

Crossbreeding experiments

A three-breed rotation cross weaned an extra pig per litter and showed an advantage of more than 400 pounds in total litter weight at 150 days of age when compared with purebred matings at the Ohio station. The crossbreds also had higher feed efficiency than the purebreds, and produced carcasses with a slightly higher percentage of lean cuts and less lard.

A four-breed rotation crossing system undertaken by the South Dakota station (coop. USDA) resulted in an increase of 2.5 pigs per litter at farrowing and weaning in comparison with outbred or linecross matings within a breed. Pigs of the four-breed cross were heavier at birth and gained faster from birth to weaning age.

During the past 9 years the Washington station has developed a meat-type strain of swine from original matings of Landrace boars and Chester White sows. The new strain compares favorably with purebred Chester Whites in growth rate and efficiency of feed utilization and produces high quality carcasses with significantly higher yields of primal cuts and less lard.

Time of mating

The influence of the number and time of mating sows on the percentage of sows settled and litter size at farrowing has been watched for several years at the Missouri station. Sows mated twice at intervals of 12 to 24 hours in the same estrus period brought increases of 23 percent in conceptions and averaged one more pig per litter than single matings. Breeding sows on the first day of estrus had no advantage over breeding them on the second day when only one mating was made.

Regulated feeding and reproduction

Animal scientists at the Wisconsin station have compared the effect of full-feeding and limited-feeding of gilts on ovulation rate and embryo survival. Limited-fed gilts receiving about two-thirds of a full ration reached sexual maturity at a younger age than full-fed gilts, and when mated during the second estrus, they produced fewer ova. A significantly higher percentage of the ova survived, however. At the twenty-fifth day of gestation the limited-fed gilts averaged one extra embryo per gilt compared with the gilts that were self-fed prior to breeding and during the gestation period.

Pork Production More Efficient

Low protein level ration

Pork production costs can be lowered by feeding less protein to growing and fattening pigs than is generally recommended. At the Arkansas station, pigs fed a 10-percent

protein level from 100- to 200-pounds body weight, gained as rapidly and much more efficiently than those fed the same well-fortified ration with 15 or 20 percent protein. Feed costs for the low protein level were $2.77 less per 100 pounds of gain than those fed the high protein ration.

Cottonseed meal tests

As a protein supplement for growing and fattening pigs, cottonseed meal containing less than 0.4 percent of free gossypol proved fully as satisfactory as soybean meal in tests conducted by the Louisiana station. Pigs fed the cottonseed meal from 70 pounds to slaughter weight gained as rapidly and efficiently as those fed soybean meal, with no significant difference in backfat thickness, yield of primal cuts, or hardness of fat.

Pelleting ups daily gains

Pelleting a well-balanced ration for growing and fattening swine improved both rate and efficiency of gain in 2-year tests conducted by the Montana station. The pellet-fed pigs made an average daily gain of 1.88 pounds compared with 1.62 pounds for pigs fed the same ration in meal form. The pellet-fed pigs were ready for market 14 days earlier. The savings in feed cost from use of the pelleted ration amounted to $2 per pig.

Inedible fat in rations

Substitution of 10 to 15 percent of inedible animal fat for part of the corn in a ration fed to growing-fattening pigs improved growth rate and efficiency of feed utilization in tests at the Florida station. In these tests, the added fat had no adverse effect on carcass grade, dressing percentage, backfat thickness, or firmness. On the other hand, the North Carolina station found that backfat thickness was significantly greater on carcasses of pigs fed 10 percent of fat, whereas yield of primal cuts was not greatly affected. Pigs fed 10 percent of fat gained slightly faster and more efficiently than those receiving higher amounts. Lard used at levels of 1 to 4 percent of the ration had no significant benefits in Indiana station tests.

Pork quality influenced by feeding practices

Animal production research indicates that restricting feed intake of growing hogs to favor muscle development without excessive fattening may provide a practical means of improving carcass quality. Pigs self-fed a ration containing a medium level of total digestible nutrients (TDN), from weaning to normal slaughter weight, yielded carcasses that were much leaner, firmer, and higher-grading than similar pigs receiving a high level of TDN, in tests at the Wisconsin station. Limiting feed intake by diluting the basal ration with ground corncobs and alfalfa improved feed efficiency, but average daily gain and dressing percentage were lowered. Color of lean and size of ham and loin muscles were equal to those of pigs fed the control ration, whereas pigs fed a low-level of TDN produced under-finished, inferior carcasses. Similar studies at the Indiana and Missouri stations also show that limited feeding of corn, under both dry lot and pasture conditions, resulted in carcasses with a higher proportion of lean and less fat when compared with the normal practice of full-feeding.

Hormone alters carcass quality

In tests conducted by the Indiana station (coop. USDA), carcass composition of slaughter hogs was altered appreciably by daily injections of bovine growth hormone, beginning when the animals were at 100-pounds body weight and continuing until they averaged about 220 pounds. The carcasses of hormone-treated pigs had more protein and water and much less fat than those from the control lot. Daily gains were improved only slightly, but there was a marked improvement in efficiency of feed utilization.

Protein needs of baby pigs

Tests show that there is a marked change in protein requirements of pigs during the normal suckling stage. Minimum requirements were strongly influenced by quality of the protein fed. When dried skim milk was used by the Illinois station as the source of protein in a synthetic milk diet, baby pigs, 1 to 4 weeks of age, required 22 percent protein for optimum growth and efficiency of feed utilization. Reduction of the protein level to 10.2 percent resulted in low feed consumption with poor gains and feed efficiency. Performance improved gradually with increasing levels of protein up to 22 percent. For pigs 5 to 9 weeks of age, a 12-percent protein diet was equal to higher levels and was superior to a 10-percent protein diet.

Using a vitamin-free casein, the Oklahoma station found that a 41-percent protein diet produced maximum weight gains and feed efficiency in very young pigs, 12 to 24 days of age. As the pigs approached 8 weeks, 20 percent protein was as satisfactory as higher levels.

In similar studies, the New York (Cornell) station used a simulated sow's milk containing casein and a pure soybean protein supplemented with methionine. For pigs 2 to 30 days of age, highest growth rate and feed efficiency was obtained with a 32-percent protein diet. Growth was retarded at levels of 16 to 20 percent protein, but relatively satisfactory results were obtained with 24 to 28 percent protein.

New prestarter feed for baby pigs

The Iowa station has developed a prestarter dry feed for baby pigs that may make it practical to wean pigs as early as 1 week of age. Seven-day old pigs fed the prestarter for 1 week and then shifted to a good starter ration were 10 pounds heavier at 8 weeks of age than sow-raised pigs that were creep-fed.

SHEEP

Breeding Experiments

Crossbreeding for lamb production

The North Carolina station evaluated different systems of breeding for the production of market lambs. Ewes bred to lamb in March and April weaned more lambs than those lambing in January and February, and the lambs averaged 10 pounds heavier in weight at weaning and graded a little higher. Western Hampshire X Rambouillet ewes bred to purebred Hampshire rams were superior in overall production to pure bred Hampshires or a four-breed rotation cross. The Western ewes sheared heavier fleeces and raised more pounds of lamb per ewe.

Factors influencing reproduction

The nature of reproductive failure of ewes bred early in their estrual season was studied by physiologists of the Kentucky station. Failure of the ova to become fertilized was the most important factor responsible for the low lambing rate of 41 percent. Although average number of ovulations per ewe was 1.47, almost 39 percent of the ewes bred did not become fertilized. In addition, approximately one of every three ewes with fertilized ova 3 days after breeding failed to lamb because of early embryonic death loss. Insemination of the ewes with semen of high motility doubled the percentage of ewes which lambed as a result of one breeding, but did not affect the embroynic death rate.

Hot weather and high body temperatures are contributing factors to lowered fertility in breeding rams. Wisconsin station research shows that shearing rams at monthly intervals during the early part of the breeding season resulted in lower body temperature, better semen quality, and higher fertilization rate compared with rams shorn once

during the spring season. Rams maintained on a roughage ration without grain settled as many ewes as rams fed a combination of grain and roughage.

Hormone use in fattening lambs

The Michigan station reports that feeder lambs treated with a combination of progesterone and estradiol, by implanting the hormone pellets under the skin 6 to 7 weeks prior to slaughter, made about 25 percent higher gains, on 20 percent less feed per pound of gain, than similar untreated lambs. Dressing percentage was lowered slightly by the hormone treatment, but carcass grades were fully equal to those of untreated lambs. Results of extensive chemical tests and assays of the meat indicate that these hormones are quickly eliminated from the meat.

Stilbestrol or a combination of stilbestrol and progesterone were about equally effective in improving gains of fattening lambs at the South Dakota station. With four different rations, the hormone treatments improved daily gain 15 to 25 percent over those made by the control group, but carcass grade and dressing percentage were lowered.

Pelleting improves gains

In Kansas station tests, feeder lambs fed a pelleted ration of corn and alfalfa hay made greater gains and consumed about 150 pounds less feed per 100 pounds of gain than similar lambs fed whole corn and long hay. A ratio of 55 percent roughage and 45 percent concentrates produced greater and more efficient gains than a 65 : 35 ratio in both pelleted and unpelleted rations. Cost of gains on the pelleted ration were considerably higher than those on the unpelleted ration due to greater expense of feed preparation.

Fat as source of energy

In lamb-feeding tests at the Texas station, inedible grades of rendered animal fats proved to be a satisfactory source of energy when used as a substitute for part of the grain. Lambs fed 5 to 10 percent of fat with a mixed ration of ground alfalfa, molasses, cottonseed meal, and sorghum grain gained as well and made much more efficient gains than the control animals. Fat fed to stilbestrol-treated lambs along with aureomycin gave similar results, but had little effect in overcoming lowered carcass quality resulting from the stilbestrol treatment.

DAIRY PRODUCTION

Artificial Breeding

Electrical device for collecting semen

Interest in research to increase the usefulness of dairy bulls is continuing. The Tennessee, Colorado, and Minnesota stations have tested usefulness of an instrument for electrically stimulating bulls to ejaculate and have found it practical from an experimental standpoint. This apparatus is expected to become helpful in collecting semen from bulls that will not or cannot serve an artificial vagina.

Ration for bulls

The New York (Cornell) station reports that during three 70-day periods sexual behavior, semen production, and fertility were similar whether bulls were fed grain and pasture, grain and hay, or grain, hay, and pasture, but the cost of the grain and pasture ration was considerably less than the other two rations.

Diluting semen from low fertility bulls

The Pennsylvania station has found that milk is a much more effective diluter than other materials for semen from bulls given a low fertility rating. According to this

research, the toxic factor for spermatozoa in unheated milk may be lactenin, an anti-streptococcal substance. With the aid of glucose radioactive C^{14} it was demonstrated spermatozoa can utilize exogenous glucose as a source of energy.

Activating spermatozoa

Artificial breeding specialists at the Ohio station claim that considerable increase in conception rate may be obtained by activating spermatozoa with a weak concentration of sodium carbonate. The increased conception rate is due to a temporary increase in motility of the spermatozoa.

Stored semen longevity

Specialists in artificial breeding at the Missouri station have found that semen produced in May and June will usually live longer when stored than semen produced at any other time of the year. The Louisiana station reports that bulls produce a less viable semen when the environmental temperature rises above 80° F. for an extended period.

Reproductive Troubles

Hormones increase conception rate

The Illinois station has obtained a 10- to 15-percent increase in conception rate when oxytocin or epinephrine was given intravenously at the time the cow was bred naturally. Previous research had shown that these two hormones affect uterine motility.

Adrenal influence on breeding efficiency

Oregon station scientists have discovered a correlation between the pathological syndrone of the adrenal gland and the breeding efficiency of dairy cattle. At the California station it was found that infertility in the cow resulting from abnormalities of the adrenal can usually be detected by measuring the excretion of ketosteroids in the urine. Sterile cows usually have from one-third to one-half as much of this hormone in their urine as normal cows.

Causes of delayed breeding

Washington station scientists have examined the causes of reproductive failure in dairy cattle. Of 394 cows infected with vaginitis none eventually became sterile, whereas 8 percent (275 head) of those with an infected uterus became sterile, 15.7 percent (89 head) with infected cervices, and 50 percent (5) with infected fallopian tubes. Cervical or uterine infection preceded cystic ovaries in 35 percent of the cases. Results to date at the Louisiana station indicate that poor management, Bang's disease, leptospirosis, and cystic ovaries are the most important causes of delayed breeding and sterility in the dairy cattle examined in this State.

Some failures due to bulls

The bull may be the cause for a cow's inability to conceive on first service. The New York (Cornell) station found in heifers slaughtered 33 days after service that normal embryos were recovered from 46.7 percent of 15 heifers bred to low-fertility bulls, whereas 80.9 percent of 21 heifers bred to high-fertility bulls were carrying living embryos.

Poor conception usually not inherited

The heritability of services per conception was almost zero (0.026) and that of calving interval was zero, at the North Carolina station. Washington station data on cystic ovaries indicate that heritability is low or nonexistent. Age and level of production

do not appear to be correlated with the incidence of cystic ovaries. In a large herd in Washington the records show that age had little influence on services per conception until about the eighth conception. Combined data from the same station indicate a correlation between age of sire and services per conception of -0.096. At the Wisconsin station no difference was found between outbred and inbred heifers in their reproductive efficiency.

Rumen Physiology

Fibrous feeds needed for digestion

The Wisconsin station reports that when the roughage fed to milking cows is sharply restricted, the fat test tends to drop (p. 4). This connection between amount of roughage and milk secretion appears to be related to the amounts of the various fatty acids produced during digestion, especially the amount of acetic acid.

Antibiotics not needed by heifers

Iowa station scientists found that the celluloytic enzymes produced by rumen micro-organisms are not present as such in the rumen fluid but are associated with the bacterial cells. The optimum temperature for these enzymes to reach maximum activity was 40° C. The station also reports there is no advantage in feeding antibiotics to heifers from 6 months to 3 years of age. No difference in feed utilization or breeding efficiency was noted between the heifers fed aureomycin and those in the check lot.

In spite of the fact that aureomycin acts as an antibiotic in most instances, Michigan station scientists have found when it is fed to ruminants in limited amounts the total bacterial count of the rumen contents and feces increases. Peculiarly enough, the number of various streptococci decreases and the coliform organisms increase. This differential response may prove to be highly significant.

Metabolism of carbohydrates in rumen

Maryland station scientists reported that only six amino acids were broken down in the rumen (supposedly by the rumen flora), but that all carbohydrate substances tested (those commonly found in feeds) were metabolized. No appreciable differences were observed in the production of volatile acids in the rumen of cows fed alfalfa hay alone as compared with those fed alfalfa hay plus 6 pounds of starch daily. The station also reported that the presence of hydrogen gas in the rumen has a pronounced effect on methane production and that formate yields much higher quantities of methane than any other substrate.

Dietary prevention of milk fever

California has found that a low-calcium high-phosphorus diet fed for one month before parturition will effectively prevent milk fever (parturient paresis) in dairy cattle. It appears to these station scientists that the incidence of milk fever is directly correlated with the calcium-phosphorus ratio of the prepartum diet.

New ketosis treatment

Ketosis is one of the more serious noncontagious diseases that affect high-producing dairy cows. Earlier work at the Maryland station has led to the general use of ACTH (adrenocorticotropic hormone) in treating this disease. This past year the same station reports marked clinical improvement of affected animals following intramuscular injection of 4 grams of 11-ketoprogesterone.

Hormone failure may affect milk flow

As a result of some fundamental studies on the physiology of milk secretion, Wisconsin station scientists are of the opinion that lack of persistency in some cows may be

due to the insufficiency of a hormone which expels the preformed milk from the secretory system at the time of milking.

Lightening in hair color

The Missouri station has some evidence that the lightening in the hair color observed in animals kept at high environmental temperatures is due to depressed thyroid activity. Full radiation at 80° F. and above decreased the thyroid activity of both the Holsteins and the Jerseys in the Missouri experimental herd.

Body temperature, milk yield ratio

Louisiana station research indicates that on the average, for each degree Fahrenheit increase in body temperature of a cow, there is a 2.14 pound decrease in daily yield of fat-corrected milk. Since this reaction varies with different cows of the same breed, the station recommends breeding for cows whose body temperature remains below average on hot days. Crossbred Red Sindhi-Holstein cows had a lower body temperature on hot days than Holstein cows.

Calves

Calf needs hay and grain at 2 months

According to dairy husbandmen at the Wisconsin and Michigan stations, a calf's rumen begins to function as a specialized organ when the calf is about 2 months old, providing the calf has access to hay and grain. If considerable milk is fed, the rumen bacteria fail to develop in the usual numbers found at this time. On hay and grass exclusively the maximum efficiency of the rumen is attained when the calf is around 6 months of age.

Lactose in synthetic rations

Calves do better on a synthetic milk ration if the latter contains some lactose which enables the calf to more efficiently use starch and corn syrup, according to the Michigan station. This station also showed that a relationship exists between biotin and potassium. Symptoms of biotin deficiency on a low-potassium diet were cured with either biotin injections or potassium supplementation.

Digestibility of cellulose

Michigan dairy husbandmen report that nitrogen retention was not significantly increased by rumen inoculations of young calves. The station also found that the digestibility of cellulose was less when a 2:3 ratio of hay to grain was fed than when either 4:1 or 3:2 ratios were fed, regardless of the type of hay used. Calves changed abruptly from a 2:3 to a 4:1 ratio digested cellulose equally as well as control calves fed continuously on a 4:1 ratio.

Wetting agent stimulates growth

A non-ionic surfactant (wetting compound), Ethomid C/15, stimulated the growth of calves 33 percent over those receiving only a calf starter and a good grade of roughage at the Kentucky station. Ethomid C/15 did not appear to prevent scouring.

Animal Breeding

Relation between type and butterfat

The relationship between type and butterfat production is almost nil according to the West Virginia station. In Ayrshire cattle the correlations between the components of type and butterfat production ranged from 0.00 to 0.14. The estimates of the phenotypic and

genetic correlations between final type rating and butterfat production were 0.09 and -0.12, respectively. Nebraska station scientists have obtained somewhat similar data for Holsteins whose correlation between productive life and type score was 0.215.

First lactation and heredity

Differences in first lactation records appear to be 28 percent hereditary in a large herd examined by Missouri dairy scientists. The heritability of differences in best lactations decreased to 13.4 percent.

DAIRY INDUSTRY

Controlling flavor in cheese

The pleasant butter flavor in high quality dairy products is due to diacetyl, a chemical produced by the bacteria in the starter culture used in cheesemaking. The Illinois station has shown that as little as 1 part per million of quaternary ammonium compound from the wash water reduces the diacetyl content of cottage cheese as much as 60 percent. Relatively flavorless cheese was produced unless all sterilizing rinse solutions were carefully drained or washed from the equipment before being used. The Illinois workers also found that the concentration of diacetyl in starter cultures could be increased from 5 to 20 times by aeration and agitation. A slight increase in acidity also aided flavor development in the starter.

The Ohio station reports that in the manufacture of Swiss cheese the addition of 0.5 percent yeast extract to a reconstituted milk starter after 4 days of incubation increased the production of acid from 2.25 to 4.5 times in comparison to that produced in the control batch. The addition of 0.1 percent peptonized milk or 1 percent casein hydrolyzate to the milk medium resulted in increases up to 350 percent in acid production. This station has also reported that, in order to have a characteristic flavor, Swiss cheese must have a minimum proline concentration of 12 milligrams per gram and a minimum propionic acid concentration of 9 milligrams per gram.

Chemical changes made by micro-organisms

The Iowa station has tried to identify the various metabolites produced by Streptococcus lactis. This station found the protein-free fraction of skim milk incubated with S. lactis contained 3 peptides to begin with, 5 after 24 hours, and 6 after 96 hours. The original skim milk fraction contained 5 amino acids. After growth of S. lactis in the media, aspartic acid, lysine, phenylalanine, proline, serine, threonine, and tyrosine appeared.

The Illinois station has attempted to determine the extent of proteolysis produced by each of the micro-organisms or agents used in the manufacture and ripening of Limburger cheese. Proteolytic action produced by each of the micro-organisms and rennet extract was uniform. The amino acids liberated from milk protein were the same for each agent. Glutamic acid was always the first amino acid to be split off from the protein molecule.

The Ohio station has been able to manufacture Provolone cheese equal to imported cheese without crude rennet pastes. One of the secrets of their success has been in maintaining the proper balance of glutamic acid from the milk protein and free butyric acid from the milk fat.

The Washington station has shown that the bacteriophage active against the lactic streptococci will remain viable in the desiccated form for a period in excess of 90 months when kept at a temperature of 55° F. These observations emphasize the necessity of preventing contamination of the plant equipment with these disease organisms.

The Pennsylvania station has been experimenting with the manufacture of Trappist cheese. It found that successive washing of the curd with water held at 94° F. reduced the percentage of total nitrogen in the curd that was water soluble and hastened the curing process.

The Pennsylvania station has identified the substance responsible for the characteristic Roquefort cheese aroma as 2-heptanone. The compound is formed by the action of Penicillium cells on the salt of caprylic acid. The aroma and possibly the flavor of mold-ripened cheese is produced by incomplete oxidation of caprylic acid in the butterfat.

Unusual Properties of Milk

Milk exposed to ultrasonic waves reacts in unexpected ways. For instance, the Wisconsin station found the content of oxygen, nitrogen, and carbon dioxide in milk was reduced by ultrasonic treatment. The higher the frequency of ultrasonic waves, the more efficient was the removal of these gases. Ultrasonic treatment of milk at low intensity caused the small fat globules to be oriented into lines as if they had been trapped in the serum. The Wisconsin scientists are attempting to discover the significance of this phenomenon.

When menadione, the precursor or substitute for vitamin K, was added to milk at 37° C., it kept the milk sweet for significantly longer periods of time than untreated milk, the Florida station reported. Its effect on keeping quality is not due to greater bacteriostatic action of the milk, since the feeding of menadione did not affect the normal rate of milk souring or the rate of lactic acid development by dairy cultures. Menadione in many instances lowered, though not uniformly, the susceptibility of copper-induced, oxidized flavor in milk.

Indiana station scientists report that although raw milk produced in the cooler months of the year had lower bacteria counts than milk produced in the warmer months, the rate of bacterial increase at 40° F. was greater in the milk produced in the cooler months.

The Pennsylvania station found that methional (methyl-mercapto-propionaldehyde) in concentrations as low as 0.05 p. p. m. gave to milk an undesirable "sunlight" flavor. Careful research has shown that methional is produced by the action of riboflavin on methionine in the presence of sunlight.

Condensed and Powdered Milk

The Washington station reports that disodium phosphate was the most effective salt for stabilizing milk proteins for drying. But the amount of fat and the efficiency of its homogenization proved to be more important in affecting the dispersability of the powder than stabilization of the protein. Another important finding was that storage at 45° F. or lower solved many of the problems of milk powder wettability. Dairy technologists at the Indiana station found that warming the powder to 90° to 100° before it is reconstituted further improves the wetting properties.

New Dairy Products

Orange-flavored ice cream

The Florida station recommends a variegated orange ice cream which combines two local products (orange juice and milk) into a nutritious and appetizing food. The formula finally worked out at the station has become so popular on the university campus that it now comprises 10 percent of total sales. One of the technical problems involved was the removal of the high acidity of the citrus juice which tended to destabilize the milk proteins. The true fresh fruit flavors are retained. Besides the pleasing flavor combination, the new ice cream has an eye-catching appeal.

Dry starter for cottage cheese

The Wisconsin station has developed a dry starter for making cottage cheese and buttermilk that has remained active for 14 weeks when stored at -20° F., or for 2 weeks at room temperature. Frozen and dried, the starter has produced consistently good results, and the flavor is excellent.

New cottage cheese dressing

Many stations have been interested in developing new cheese spreads. The Washington station has made a highly viscous cottage cheese dressing by pasteurizing 12.5 to 13 percent butterfat milk at 160° F., cooling to 75°, and immediately homogenizing at 3,500 pounds or higher per square inch with a single-stage homogenizer. A cultural salad dressing may be made by cooling the pasteurized product to 70° to 75°, adding 1 to 2 percent buttermilk culture, and homogenizing at 4,000 pounds per square inch, single stage. The dressing is then incubated 12 to 14 hours at 70° and placed in cold storage.

VETERINARY RESEARCH

Expanded Attack on Animal Diseases

Gastrointestinal parasites of ruminants

In response to demands by livestock producers, agricultural experiment stations are stepping up scientific research to solve fundamental animal disease and parasite problems. In the past year a regional project on gastrointestinal parasites of ruminants was organized with cooperation by nine southern experiment stations and the Department of Agriculture. This regional study recognizes that internal parasites, both as primary and secondary causes retarding the growth and well-being of livestock, constitute a major restriction to productive animal agriculture in the South. Although agronomists and soil scientists have found and adapted forage varieties and developed cultural practices that permit almost year-round pasturing of cattle in much of the area, the desired livestock expansion cannot take place until the problems of internal parasites and accompanying diseases are brought under control.

Vibriosis of sheep

A second example of expanding veterinary research to aid livestock producers is that of the western regional study on vibriosis of sheep. With severe lamb losses in 1952, wool growers urged expansion of the limited research on vibriosis. No single State had the funds for an all-out attack on the problem. A regional research project, with the western experiment stations and the Department cooperating, is now well under way and the various phases have been assigned to the different stations and cooperating agencies.

New Diseases and Other Findings

Detecting clorinated naphthalene

Previous reports on the agricultural experiment stations have told the story of pinning down X-disease (hyperkeratosis) in cattle. After the chlorinated naphthalenes were proved to be causative agents, it became necessary to find a way for detecting their presence in lubricants or feeds. A colorimetric method, developed by the Virginia station, has proved useful and is now employed in field studies.

Abortions caused by Leptospira

Leptospirosis, a disease affecting man and animals, was reported for the first time in the United States by the Storrs station (Connecticut) in 1944. It has since become a

disease of prime economic importance to the Nation and has now been recognized in at least 40 States. For some time it has been suspected that leptospirosis was responsible for premature births of calves, lambs, and pigs. Now the Illinois station reports that it has actually isolated Leptospira from aborted pig and sheep fetuses.

Atrophic rhinitis of swine

Swine producers are faced with the problem of a newly recognized disease known as atrophic rhinitis--a wasting inflammation of the nasal passages. In its early stages the disease is extremely difficult to recognize. Sneezing is frequent among the pigs of an infected litter and a discharge usually comes from the nose. Some pigs may develop pneumonia. The economic loss to the swine producer results from the general unthriftiness in a herd affected with the disease.

At the Iowa station a filtrable agent has been recovered from the nasal passage of affected swine. It has been successfully cultivated in chicken embryos where it produces characteristic lesions. The exact part it plays in atrophic rhinitis remains to be determined. It is thought to be a pleuropneumonia-like organism. Other causes which have been suggested as being related to this disease are genetic factors, a virus, and a protozoan.

An X-ray procedure has been devised at the Indiana station to follow the course of the disease in the intact experimental animal. This technique may prove valuable in the diagnosis of the disease in the field.

Mucosal disease of cattle

Presence of a previously unknown malady, mucosal disease of cattle, has been reported in a number of States. It resembles X-disease (hyperkeratosis) and also virus diarrhea reported by the New York (Cornell) station in 1946-47. However, mucosal disease is not comparable to any previously described ailment, the Iowa Experiment Station learned. An early symptom is rise in body temperature. After 24 to 48 hours of fever, the temperature drops rapidly back to normal. The sickness rate varies from 5 to 20 percent per herd, with death following in 3 to 10 days among a large number of the sick animals. Affected cattle show complete loss of appetite, constant or intermittent diarrhea, profuse salivation, emaciation, dehydration, and depression. A foul-smelling discharge often hangs from the nostrils and mouth. Experimental efforts to transmit the disease by contact, feedings, and injections have failed. The cause is not known and so far no satisfactory treatment has been developed.

Hog cholera treatments

That science does not consider present treatments against hog cholera the final answer revealed in continuing research under way in the Department and at State experiment stations. Many years ago a combination treatment, in which antiserum was injected by needle simultaneously with the hog cholera virus, was accepted as an effective control method. Now and then, however, there were post-vaccination losses and autopsies of animals that died showed hog cholera lesions. After years of careful study of the post-vaccination losses, USDA scientists determined that there are variants of the hog cholera virus which account partially for irregular results that follow vaccinations now and then. Offsetting the seriousness of these findings are recent developments in the commercial preparation of modified vaccines that are now available.

Because of the economic hazard which hog cholera constantly means to farmers, experiment stations are continuing research on this disease and its preventives. For example, a Minnesota station study showed that use of modified vaccines on pregnant sows will so affect the developing fetuses that they will die or become seriously damaged, with a resultant loss in litters. The Virginia station has demonstrated that ultraviolet irradiation is not a satisfactory means of modifying the virus. In earlier studies they found that nitrogen mustard would modify it to a point where it will not cause disease.

V-E research in California

Since the original discovery of V-E (vesicular exanthema of swine) in California in 1934, many studies concerning the disease have been conducted at the State experiment station and much of the present knowledge concerning this disease grew out of the California research. Only swine have been found reliable as experimental animals, making research expensive and slow. Of the several small animals that can be used experimentally, only the hamster has shown some evidence of reasonably successful experimental infection.

In the early studies of the disease it was determined that there was a plurality of viruses. Although the early virus cultures are no longer available for comparison, in a study of 263 samples gathered from recent infections the California station recognized 3 distinct antigenic serotypes. This station has developed a scientific test which is regarded by veterinarians as reliable for identifying the disease and in differentiating the virus into its immunological type.

Since the sudden spread of V-E in 1952 to 41 States, 43 States have enacted regulatory statutes dealing with feeding of garbage containing raw scraps of pork, considered the primary agent in spreading the disease.

Preventing worm losses in lambs

Rations fortified with blood-forming minerals, such as steamed bonemeal or trace-mineralized salts, will help lambs survive stomach worm invasions but the use of the salts alone increases the number of worm eggs passed in the feces. On pastures the dropped worm eggs become a source of reinfestation of pastured lambs. The Wisconsin station showed that pastured lambs will not consume enough bonemeal to fortify their diets and when fed trace-mineralized salts alone heavy death losses were suffered, whereas no deaths took place in flocks that were fed trace-mineralized salts to which dicalcium phosphate or phenethiazine was added. The conclusion drawn from the Wisconsin experiments is that in order to prevent lamb losses from stomach worms under pasture conditions trace-mineralized salt should never be fed alone but should always contain an appropriate amount of either dicalcium phosphate or phenothiazine.

Mass vaccination for Newcastle disease

A simple method to vaccinate chicks for Newcastle disease has been tested at the Storrs (Connecticut) and Texas stations. It is performed by simply adding live virus vaccine to clean drinking water. Thus chicks drinking the water immunize themselves. The first method of mass vaccination was to spray the vaccine over the heads of the chicks in closed rooms. The New Hampshire station has used another method. They administered a vaccine prepared in the form of a dust by dusting it over chicks.

These methods represent a labor saving which will practically eliminate labor as a cost in vaccination. Previously, the administration of this vaccine by the wing-web puncture method or by dropping it into the nostril or eye required handling each bird individually. Besides saving labor, mass immunization procedures make it easy to repeat the vaccination periodically to insure continuous maximum protection against the disease.

Chronic respiratory disease of chickens

Air-sac infection of poultry also known as chronic respiratory disease, has caused great concern among poultry growers, particularly broiler producers, during the past few years. The annual loss from air-sac infection to the broiler industry is approximately 10 million dollars.

Current research by 11 State experiment stations (Virginia, Storrs (Conn.), Massachusetts, Delaware, Maryland, Georgia, North Carolina, Cornell (New York), Texas, Minnesota, Washington) and the Department has established that this infection can be

transmitted from hens to their chicks through the egg. Egg transmission may be related to outbreaks of chronic respiratory disease in growing birds. It has been shown experimentally that transmission in the incubator may occur during hatching.

Hemorrhagic disease of poultry

A poultry ailment known as hemorrhagic disease has been observed throughout the broiler-producing areas. The cause is not known. The disease is characterized by lesions--hemorrhages in the small intestines and ceca--similar to those of coccidiosis. Some scientists believe that hemorrhagic disease may be related to the use of antibiotics and other drugs; others think it may represent a nutritional deficiency. The West Virginia station has produced the hemorrhagic condition in laboratory birds by faulty nutrition and overmedication.

Causes of chicken arthritis

An organism not related to any previously associated with arthritis in chickens has been discovered at the Texas station. It produces a chronic disease characterized by swollen joints and tendons. The disease has been successfully transmitted to normal birds by hypodermic injection. Evidence has been obtained that this agent can be propagated in 7-day-old chicken embryos. The disease has appeared in several broiler-raising States and is of serious economic importance to poultrymen because of the large number of ill and crippled chickens which result.

Horse influence and abortion caused by same virus

Recent studies at the Kentucky station have shown that equine influenza and equine virus abortion are caused by the same virus. This virus has been successfully adapted to suckling Syrian hamsters and shows promise of providing material for immunization purposes as well as material for additional laboratory and field studies.

MARKETING

Financing cooperatives

Members of farmer cooperatives in South Dakota prefer to obtain capital for financing their business operations by retaining patronage refunds, the State experiment station found. One plan suggested is to put part of the refunds in permanent capital and revolve the rest. In many cooperatives better management practices are needed. Often excessive inventories and large accounts receivable tie up great amounts of capital which could be put to better use. In addition, better financial planning is often needed. To develop a good financial program, it is necessary to have member participation. More complete information about the operations of the cooperatives has to be furnished if such member participation is to be a reality.

Reducing milk marketing costs

The Vermont station, studying gallon-jug distribution of milk as a possible way to reduce distribution costs, found that gallon jugs do not guarantee any appreciable cost reduction. The gallon container costs about 0.4 cent less and the cap 1.2 cents less than four 1-quart containers and caps, but the filling cost in gallons might average 0.4 cent more. Therefore, the saving averages only 1.2 cents per gallon or 1/3 cent per quart. In addition, there might be some saving in weight and space. The extent to which any dealer could capitalize on the possible savings would depend on his volume of gallon jug sales. Vermont dealers who have used gallon-jug distribution have not found any substantial consumer demand for milk in this quantity.

Distributing milk in paper containers

In a region-wide study, the North Central States found that paper packaging of milk is more responsible than any other factor for the shift to store sales and the expansion

of milk distribution areas. Both have increased milk consumption in the region. Distribution of milk outside the city or town in which it was packaged was unimportant until after World War II. By May 1952, 83 percent of the plant operators in the North Central region who packaged milk in paper containers had outside sales, and 23 percent of those with outside sales had distribution areas that extended 100 miles or more from their plants. The volume of milk in paper containers outside local markets comprised 12 percent of all bottled and packaged milk marketed in the region.

Consumer response to milk vending machines

To determine the effect of the vending machine on milk sales, the Maine station made observations for a year in four different locations where from 200 to 700 people had access to the machines. Consumers who patronized the venders said they liked the cold milk and the mechanical operation and convenience. Strong preferences were shown for the chocolate-flavored product. Dissatisfactions expressed were related to mechanical failure and price. Any prejudice against paper containers disappeared after continued use. The vending machines were particularly popular at midmorning and midafternoon refreshment periods--also at noon for those who carried lunches.

Occupation of the persons, period of access to the milk, and availability of other beverages were more important than number of persons in determining successful location. At a selling price of 10 cents, allowing a gross margin of 2.2 cents per half pint, it is estimated that minimum sales of 500 units per machine per week would be necessary for profitable operation.

Credit important in marketing broilers

The availability of credit is perhaps the most important single item contributing to the large and expanding production and marketing of broilers. The Georgia station learned that 97 percent of the growers in North Georgia use credit to purchase chicks, feed, and supplies. Furthermore, some of the contracts permit growers to shift a large share of the risk of losses to feed dealers, who supply a large share of the credit in return for a share of the anticipated profits.

Market prices for cattle and calves

Auctions provide the only organized market outlet for cattle and calves in Florida at which prices are reported on the basis of comparable grades in specific locations. The number of animals sold grading Good, Choice, and Prime was not large enough to establish a reliable market price in any of the auctions studied. Prices paid for cutter, canner, utility, and commercial grades of slaughter animals in one large auction compared favorably with prices paid for comparable animals in national market centers, after making allowances for transportation costs. Prices paid for comparable animals in a small auction averaged as much as $2 lower per hundredweight. Farmers in Florida received higher and more stable prices when they sold animals at large auctions.

Lint cleaning costly to Arizona farmers

Evaluation by the Arizona station of grades obtained on over 1,000 bales of cotton before and after lint cleaning in 16 Arizona gins reveals that the improvement is frequently not sufficient to offset the weight loss and charges for the lint-cleaning service. The study indicates that lint cleaning of Arizona cotton which, without cleaning would grade Strict Low Middling, is a practice presently unprofitable to farmers. Any cleaning of cotton of higher grades is carried on at a substantial expense. On the other hand, lint cleaning of cotton of lower grades appears to bring producers a profit.

Efficiencies in packing lemons

Within the last three years, 90 percent of the lemon industry has converted to a new package developed by the California station. A half-box carton made of corrugated paper

is used in place of the nailed crate with its individually wrapped fruit. The shift in the packaging system includes a new method of filling the container called "University Volume Fill." It involves (1) sizing the fruit with mechanical sizers, (2) rolling the fruit into the box by a simple flow arrangement until the box is approximately filled, and (3) settling the fruit down into the box by means of a shaker. After this the box is automatically sealed in a standard glue and compression unit and is ready for shipment. The specific saving in labor by this packaging method, along with the saving in wrapping labor, constitutes a reduction in cost from over 25 cents per standard box to about 4 cents at the present time. Other benefits are less cost for the box material itself, freight and icing charges en route are decreased, and claims for damages against the railroads are greatly reduced, while the retail store no longer has to unwrap fruit and dispose of the wraps. The immediate packinghouse net cost reductions amount to 39 cents per box, or approximately 3 million dollars to the industry a year.

Localized and specific market information

The orderly flow of produce to market is aided by the availability to farmers of accurate and adequate information about market conditions. The Michigan station (coop. USDA), seeking ways to improve present methods of reporting market news, found that much of the mass media provided only "canned" information regarding market conditions in distant urban markets, but failed to obtain and issue information about local markets. Farmers also expressed a need for "trend data" in the daily reports, but most of them found little use in "futures" quotations. They also wanted more specific price quotations on poultry, and steps were taken to indicate the price at which most of the supply is moving, for example, "63 cents to 67 cents, mostly at 64 cents." Additional studies are planned, with the communication systems at the community level.

High quality eggs through integrated egg marketing

An integrated egg buying and handling system gives producers an incentive to produce high quality eggs, say Wisconsin farm economists (coop. USDA). This system puts the functions of several middlemen--the local buyer, central assembler, broker, wholesaler, jobber, and possibly the retailer--in the hands of one or two organizations, thereby reducing marketing costs. The farmer thus gets a good share of the premium paid in retail stores for quality eggs, and has an incentive to produce a high quality product. As an example, the eggs in one "integrated area" graded more than 90 percent grade "A" large, compared to about 50 percent of this grade under the unintegrated system. This system benefited the consumer as well as the producer.

Quality and prices of Texas turkeys

A study of the factors influencing the market quality and prices of Texas turkeys was conducted by the Texas station (coop. USDA) during 1950-53. In 6 processing plants, 70 percent of the turkeys processed qualified as U.S. Grade A, 17 percent Grade B, and 4 percent Grade C. Of the 21 percent below Grade A, 27 percent were undergrades because of poor fleshing or lack of finish; other important causes were bruises, skin tears, and blue black. Large growers marketed their turkeys when they were about 3 pounds heavier than those raised by small growers and received $1.27 more per bird. An extensive campaign has been started by all segments of the Texas turkey industry to increase flock size, to encourage the production of high quality turkeys, and to stimulate orderly marketing and pay on the basis of quality.

More accurate grading of market hogs

A system for more accurately grading market hogs has been developed through research at the Ohio station (coop. USDA). By this system, which takes into account average backfat thickness and hind leg and body lengths, standards have been developed for the live-grading of hogs into three grades. Limited initial use of the system has proved profitable to Ohio farmers. With modification, the standards can be adapted to meet the present consumer demand for pork with less fat.

Few farm operators expect to retire

Because they feel they cannot afford to do so, relatively few farm operators have expectations of full retirement, according to the findings of the Texas station. Life insurance protection of farm operators is inadequate, but they strive for security through the acquisition of land titles. Other methods for obtaining security receive relatively little attention by many farm people. Farm operators and workers generally favor Old-Age and Survivors Insurance for regular farm workers, oppose such coverage for short-time farm workers, and are undecided on coverage for farm operators.

Research on rural health

Rural health research conducted by the Missouri station has provided answers to rural people in meeting their health problems. Research has been conducted on such practical and critical matters as rural illness, hospital location, physician supply, and community organization for health improvement. As a result there are now more than 50 county health councils in the State. These have been organized by local people for appraising their own health situations and to carry on local projects for health improvement.

In the use of health services, the New York (Cornell) station (coop. USDA) learned in a six-county rural health study, that the services of a physician does not increase with age for individuals over 65 until the age of 80 is reached. Even then the increase is only for the general practitioner and not for the specialist. Hospital use is higher after the age of 70 than before, but does not increase constantly with age.

Hospital costs increasing

Increased operating costs in hospitals, reflected in increased charges, put hospital care almost out of reach of people in ordinary circumstances. In a study by the Virginia station, which covers a 52-year period, the station found, however, that the patient's worry about costs is being lessened somewhat by hospital and other type of insurance, but less than half of the hospital patients carry insurance for that purpose. Rising costs of all types of supplies and services, along with unpaid bills and shorter working hours, make it difficult for hospitals to avoid defects and consequently hospital room and service charges are on the increase.

Recent population trends

The decade of the 1940's according to the North Carolina station, was characterized by highly dynamic population changes which have great significance for the State's agriculture. North Carolina was shown to have more farm people than any other State but to rank fifth in percentage of total population on farms. The State has more non-white population than any other State. During the period studied more of the State's population was employed in manufacturing than in agriculture, indicating a changing home market for farm products. The migration from farms during the decade amounted to about one-third of the population on farms in 1940, but rural farm birth rates are still higher than urban birth rates. During the past 10 years, however, rural birth rates did not increase as much as urban birth rates.

Rural libraries in Utah

Although libraries have entered strongly into the growth of Utah culture, the experiment station found a great variation in library growth with respect to: (1) buildings and equipment, (2) books and facilities, (3) effectiveness of organization, and (4) community integration. On the favorable side are to be found library organization and service comparable to the best in America. In two of the four counties under study rural library organization is equal to that and in some respects superior to that found in the best

urban libraries. On the unfavorable side are many communities with no library service and in many others where library service is maintained it is inferior.

RESEARCH IN FARM ECONOMICS

Combining Farm Practices for Profit

Michigan station experiments (coop. USDA) point to considerable saving in operating costs by farmers who study their problems carefully and then combine know-how to meet them. As much as 16 to 26 percent was saved by spending more money for necessary fertilizer and using the latest cultural practices. By spending an extra $20 per acre an average Michigan wheat producer could increase yields by 21 bushels and lower costs 26 cents per bushel. Making full use of recommended practices lowered the cost of producing a ton of alfalfa-brome hay by $3.50 and a ton of sugar beets by $3.

Better and more roughage pays off

The Michigan studies (coop. USDA) also showed that feed costs necessary for producing 100 pounds of milk can be reduced by 20 to 25 percent on the average Michigan dairy farm. This can be done, first, by improving the quality of roughage and, then, by feeding more roughage and less protein and grain. Costs of feed on some farms have been reduced materially by taking advantage of protein and grain-saving opportunities and using more high quality roughage. Feeding protein and grain at a heavy rate after improving the quality of roughage results in higher feed costs than necessary. High legume, well-fertilized pastures are the cheapest sources of feed. In the Michigan experiments feed costs were reduced 30 to 40 percent when cows were turned out to pasture. During the pasture season, feed costs for 100 pounds of milk on farms having the best pasture were less than 90 cents, as compared with cost of more than twice that amount on farms having the poorest pasture.

Through the adoption of a well planned forage production and utilization program the Storrs (Connecticut) station found that the average dairy farmer could substantially increase net income during summer and winter. Many of those with small herds have sufficient land and other resources to permit a substantial increase in size of herd and by putting into practice the improved program net income can be increased by more than 2 times.

Cattle feeding in Oregon

Although finishing cattle for marketing in dry lot is a more risky business in Oregon than in the Midwest because of the higher price of feed, the Oregon station found that efficient operators can succeed in areas of low-cost roughage. The feeding of an increasing proportion of grain in relation to roughage as the feeding period advances was shown to be a more economical practice than the feeding of a constant ratio of grain to roughage during the entire feeding period.

Trend Toward Larger and More Efficient Farms

The large sized family farms can generally make more efficient use of labor and machinery than the small farms. However, losses may also be greater for larger cash operations if a sharp break in prices occurs. The Montana station showed that with dairy and hogs the average farmer with seeded irrigated pastures in the Billings area, by moderately increasing the acreage of forage and number of livestock, could have increased his income from $4,140 to $4,449 (1950-52 prices). With a more substantial increase, his income could be pushed up to $5,375. Assuming the expansion was financed with credit, the debt in either instance could have been retired the second year following the investment. However, had prices dropped for 3 years according to the 1930-32 pattern, the farmer would have ended the period in worse financial condition than if he had not attempted the expansion.

Relation of acreage to efficiency

In a study of farm organization and practices affecting potato production costs in Aroostook County, the Maine station (coop. USDA) established that farms averaging 90 acres of potatoes compared with a group averaging 11 acres had yield rates 17 percent higher, labor costs 34 percent lower, equipment costs 36 percent lower, and capital costs 14 percent lower. The per-acre costs of production on the larger farms were 23 percent less and per-barrel costs 29 percent less than on the small farms. The drastic reduction in potato acreage in 1948 to 1951 lowered farm efficiency. To compensate, the farmers tried to intensify potato production, extended livestock, and reduced the labor force.

Workload and dairy income

Size of herd, milk production per cow, man-hours per cow, and grain-milk price ratio were found by the Maine, North Dakota, and other stations to influence labor income. The New York (Cornell) station found size of dairy herd, production per cow, quantity of milk produced per employed worker, and the years required for the receipts to equal capital to affect labor income. Those farms with none of these factors above the average of the group studied suffered a loss of $1,572, whereas farms that had one of these factors above average made a cash labor income of $1,297, those with three $3,629, and those with four $4,561. The latter group averaged 46 cows per herd producing 12,100 pounds of 3.7 percent milk per cow, produced 84 tons of milk per man employed, and receipts equaled capital investment in 1.9 years. In a study of income of Matanuska Valley dairymen, the Alaska station found that the larger herds averaged larger net incomes. Farmers with smaller herds relied strongly on minor enterprises of potatoes and vegetables.

Factors affecting income from poultry

The size of flock, rate of lay, feed efficiency, labor efficiency, and mortality significantly affect income, Alabama studies reveal. Those with four or more of these factors average or better had a profit of 16.2 cents per dozen eggs produced, whereas those below average with respect to all these factors had a loss of 14.9 cents per dozen eggs.

Basic Factors for Efficiency

Know-how plus capital and motivation

In a study of factors regarding efficiency on 151 dairy farms, the Pennsylvania station learned that the 44 operators who made highest scores (averaging 86) on a dairy-knowledge test, had herds averaging 1,000 pounds higher production per cow and were earning labor incomes averaging $2,000 more than the 45 operators making low scores (averaging 44). The higher knowledge dairymen were following recommended production practices, anticipating further increases in milk production, and were seriously concerned with improving their dairy operations. The apparent influence of know-how was most evident with those having large capital investment. On farms with an average investment of $14,000 (real estate and personal property) there was an associated increase in labor income of $9.12 for each point increase in knowledge score. In contrast, the increase in labor income was $36.27 for each point increase in knowledge score on those farms with an average investment of $35,000. Although 38 percent of the operators stated that lack of capital was a major reason for not improving their herd's performance and reducing dairy labor requirements, 51 of the 58 operators indicating a need for additional funds felt that they could borrow the money. Only 45 intended to do so, however, evidencing that a correction of deficiencies in knowledge and capital would not automatically result in improving the farm business. Operators must also be motivated to make use of the knowledge and capital.

Adjustments to Changing Situations

Use of idle acreage

Research dealing with ways to put idle land to work is believed by the South Carolina station to help farmers. Improved pastures in the State increased 1 million acres from 1948 to 1952, thereby permitting farmers to realize $3\frac{1}{2}$ million dollars more from dairy products in 1952 than in 1950, an increase of 20 percent. Since the per capita supply of dairy products is relatively low in the State, the increases made for a healthier diet. Beef cattle numbers also increased. Using 1951 prices, the station (coop. USDA) figured that the representative medium-sized farm, if converted into a 30-cow Grade A dairy farm having a balanced grazing program, would yield a return to labor and management amounting to $6,500, assuming a ready market outlet. A cash crop system would produce a return of about $1,700, and a cash crop system supplemental with a 10-cow dairy enterprise would return about $1,900.

Changes through farm mechanization

Cost accounting records maintained by Minnesota farmers and available to the experiment station show that machinery costs took 26 cents out of the farmer's dollar for the period 1948-52 as compared with 18 cents for 1945-47 and 14 cents for 1928-34. With this increase in machinery costs, farmers need a larger operation to justify the higher cost of equipment. They also need more information and technical knowledge on production practices, on farm management, and on financial management.

New mechanical devices must be economical

The Washington station shows that the mechanical orchard hoist used in 1952 failed to increase work output sufficiently to cover the cost, but the machines used in 1953 could, if properly used, increase output sufficiently to pay for fixed and variable costs of machine operation. Greater efficiency in apple picking was achieved through improved picking containers and ladders. The number of boxes picked by individual pickers ranged from 50 to over 300 per day. Differences in picking methods had less to do with this than lack of individual drive among the low producers. The most promising contribution to a high picking rate was able and attentive supervision of the pickers.

Volume affects cost of operating forage harvesters

Differences in the amount of use and methods employed account for most of the variation in equipment cost in harvesting hay, the Kentucky station learned. Cost of operating field choppers were lowered from $8.88 per ton to $3.52 per ton as the average annual use increased from 61 to 288 tons. For pickup baler, the variation was from $8.75 per ton to $3.83 per ton as annual use increased from 85 to 518 tons. For a limited number of power high-lift tractor buck-rakes, the average cost was $5.11 per ton when 85 tons were handled per year. The low investment for the power high-lift buck-rake showed the importance of the latter method for the average-size Kentucky farm where volumes handled per season are low. According to studies undertaken by the Michigan station, farmers having less than 50 tons of hay to harvest annually should consider the buck-rake and hay loader or otherwise have their haying done by custom operators.

The average cost of operating hay balers in New York in 1952 was $3 per ton, and of a field chopper about $1.60 per ton of hay equivalent. Large tonnages were essential for low unit costs for both machines, but the field chopper handled a volume as small as 100 tons of hay equivalent at as low unit cost as the baler handling 200 tons.

Seeding rice by air is successful

Approximately 10 percent of the 1952 Arkansas rice acreage was planted by airplane, mainly on flooded ground. Although the Arkansas station found that seeding in water by plane is more exacting than dry-land seeding with ground equipment, an estimated in-

crease in yield of 16 bushels per acre was obtained. Using the Rice Branch Station's 9-year-average increase of 13½ bushels and 1952 prices, the gain from water seeding amounted to $28.11 an acre. Costs of applying 2,4-D by plane averaged about $2 an acre, with the cost divided about equally between cost of the plane and cost of the material.

Machine harvesting cuts potato costs

The use of complete mechanical equipment for harvesting and handling of potatoes reduces harvesting costs by one-third, according to Florida station experiments. The amount of labor needed during the harvesting period was reduced by about 50 percent and cost by about 10 cents per 100-pound packed bag. Physical damage was also substantially reduced by operating the equipment carefully and setting up packinghouses properly to handle potatoes in bulk. In one area where major damage to mechanically harvested potatoes in 1953 had been about 20 percent it dropped to less than 5 percent in 1954 after the machine was padded at points of severe impact and the conveyor chain links were protected with rubber tubing.

Irrigation systems

In analyzing the costs of surface and sprinkler methods of irrigation on comparable farms, the Washington station found the surface method less expensive. The sprinkler operator could do a reasonable job of irrigation with little or no leveling, but the investment cost exceeded the cost of leveling, ditch boxes, siphons, spiles, and other essentials for surface methods of irrigation.

Pasture irrigation

Since pastures are frequently understocked because of fear of impending drought, several stations have undertaken studies aimed at establishing reasonable cost in relation to increased income through heavier use of pasture. According to the Michigan station, although pasture yields can be increased about 25 percent through irrigation, the high cost of installation makes it a marginal practice in that State. If the cost of capital equipment can be spread over other crops, then pasture irrigation may be profitable. Costs varying from $1.67 to $34.79 per acre-inch were found by the Kentucky station, depending upon existing conditions and degree of efficiency. Irrigation of tobacco resulted in a gain of $155 per acre, but in many instances the costs were excessive.

The Shifting Scene in Farm Operation

Capital requirements and unavailability of land discourage beginners

In a study made in DeWitt County, Illinois, the State experiment station (coop. USDA), in a North Central regional project, discovered that only 46 of 118 farm-reared boys, now 27 to 31 years old, are farming. Even at the low annual replacement rate of 2.8 percent, at least 60 of those boys should be started in farming. High initial capital requirements, competition for farms from tenants outside the county, and a tendency for present operators to continue farming longer have been obstacles. Of the 72 young men not farming, 40 percent would prefer it to their present work, and two-thirds of the wives of this group are of similar mind.

Families leaving small farms

There has been heavy migration from farms of entire families comprised largely of tenants and from small farms and situations least likely to provide for the accumulation of capital, an Arkansas station (coop. Alabama, Louisiana, Oklahoma, and Texas stations) study shows. Family migration plus the rise on the agricultural ladder to ownership have been sufficient to bring about a net improvement in the level of living and adjustment on the land of those who remained. Important factors associated with the reduction in number of tenants are technological improvements, growth in opportunity for off-farm employment, changing demands for farm products, crop acreage controls, increasing use of capital on farms, and a less intensive use of hand labor.

Why small operators are leaving

The reason many small operators and tenants are leaving the farm is illustrated by a North Carolina study. Based on the 1945-49 average yield of cotton in the Piedmont, 417 pounds of lint per acre, a family with 15 acres of cotton would have to receive 35 cents per pound in order to get a net return equal to what one person working full time at the average wage of $1.15 per hour would earn in manufacturing employment in the area. The owner would, of course, want some return from land, capital, and equipment. A tenant family on a 50-50 share basis would need to receive 70 cents per pound. Since cotton prices cannot be expected to reach such levels, if farmers are to compete effectively with nonfarm employment, it will be necessary to increase the productivity of labor on farms.

In Missouri the proportion of tenancy is found to be highest on the productive land and lowest in the sections of the State where returns are barely large enough to meet capital and labor costs, leaving little surplus for payment of rents. Although individual farms vary in productivity, shares of crops and cash rent per acre tend to be what is customary in the community.

AGRICULTURAL ENGINEERING

Pilot model of mechanical grape harvester

The California station is endeavoring to place mechanical grape harvesting on a practical basis. An experimental harvesting machine that may eliminate 100 hand pickers has been developed. Grapes must be especially trellised so that clusters hang clear of the trellis and are clipped off by a cutter bar that moves directly beneath the trellis and cuts the stem. In its present stage of development the machine is adaptable to harvesting raisin and wine grapes, and further studies are planned to make it suitable for harvesting table grapes. Since a long stem is necessary for the machine to remove the fruit intact, plant breeders are seeking to develop varieties of grapes with longer stems.

Sorghum head cutter attachment

Until recently the job of harvesting seed heads off sorghum was an expensive hand operation. With the increasing use of sorghum stalks for silage in the South, the Mississippi station sought a mechanical means of harvesting the seed heads simultaneously with cutting the stalks for silage. The station developed a pilot model of a seed-heading mechanism that can be mounted on the tractor pulling the ensilage field harvester.

New friction data on forage harvesters

In the past designers of forage harvesters have assumed that an allowance of 0.3 for friction coefficients could be made for all forages, regardless of moisture content. The Indiana station has shown that the coefficient of friction varies from 0.2 for dry materials to 0.65 for grass silage material. This information becomes important in the design and manufacture of new machines since friction losses require varied horsepower under varying conditions.

Alfalfa seed losses reduced

Tests by the Wyoming station on combine-threshers operating for alfalfa seed production showed that seed losses occurred at most every point where the crop came into contact with the machine. Losses varied from 99 to 2.5 pounds per acre. Proper adjustments, changing methods of operation, and addition of simply designed parts reduced these losses as much as 17.5 pounds per acre. Excessive cylinder speed caused broken and cracked seed, which reduced germination.

The California station confirmed this fact in detailed tests that showed decline in germinability of mechanically harvested alfalfa seed was directly related to the roughness of treatment at harvest. As a result of the station's findings, California growers in 4 years reduced the amount of seed rejected for certification from 27 percent of the total of 446,000 pounds to 1.6 percent of more than 34,000,000 pounds.

Implement needs vary with weather

From a management standpoint it pays farm operators to have equipment for modifying tractors and other implements according to weather need. This was demonstrated by the Georgia station in two cotton cultivation experiments carried on in a wet season. The use of small, rotary, spring-toothed wheels next to the row in a very weedy cotton field produced good weed control plus a profit of $15 per acre when compared with results in an adjoining field where standard equipment was used. In another field, disk gangs made up of 6 disks per row did even better and showed a $27 per acre profit.

Safe hoeing at 18 miles an hour

The Texas station has designed a two-row, trailer-type rotary hoe which has been operated without difficulty at field speeds of 15 to 18 miles an hour in contrast to the average operating speed of 5 to 6 miles an hour with conventional rotary hoes. In the past, speeds above 15 miles an hour have been considered dangerous. Further trials will be necessary before the new design can be introduced by manufacturers for practical use. The design also calls for converting the implement into a row-crop roller for firming the soil over planted seed and, with the necessary attachments, for applying pre-emergence chemicals at time of rolling.

Improved cultivator for flaming cotton

A major obstacle to mechanized cotton production has been removed through development by the Arkansas station of a new-design flame burner. The burner has a deflector attached at an angle to the combustion chamber which controls the upward expansion of the flame and confines it to an effective height of only 2-1/2 inches. Thus grass and weeds in the cotton row may be flamed when the young cotton plants are only 4 to 5 inches tall. Under current practice cotton plants have to reach a height of 8 inches before they can be flamed, and the grower meanwhile must depend on chemical control to keep down competing weeds and grasses.

New lime and fertilizer spreader

The Tennessee station and the Tennessee Valley Authority have developed a ground-limestone and fertilizer spreader that will operate satisfactorily with relatively wet materials on irregular-shaped fields in mountainous terrain. Present commercial machines are not adequate to distribute ground limestone at equal rates regardless of physical conditions, to handle wet materials, or to distribute jointly ground limestone and fertilizer unless they are mixed in proper proportions prior to filling the hopper. The new spreader shows promise of adequately handling limestone with up to 12 percent moisture content. At 12 percent moisture content, ground limestone has the consistency of wet cement.

Automatic feed grinding and handling

The Illinois station (coop. USDA and industry) developed a pilot model for an automatic electric feed-processing system. The model removed ear corn from a crib and small grain and feed supplements from bulk storage bins and automatically fed these products into a grinder. The blended feed ration was conveyed to a feed wagon or a prefeeding storage hopper. An electrical control unit operated the switches, timers, relays, and other devices in preselected sequences to control the various conveyors, drags, metering devices, and grinding mills.

Automatic feed rationing

A mechanical feeder developed by the Pennsylvania station makes it possible to quickly and accurately feed measured amounts of a mixture of ground grain and concentrates to individually stanchioned dairy cows. An endless chain running in an overhead trough drags the feed mixture from a storage hopper to individually adjusted feed-metering receptacles located over each manger. The feed for each animal drops from these receptacles to the feeding floor through flexible metal tubing after tandem-connected feed release valves are tripped by the operator.

Electric silage conveyor

The Minnesota station developed a conveyor that takes the silage from the silo and distributes it uniformly along a feed bunk. The conveyor weighs and distributes a ton or more of silage in 30 minutes at an operating cost of approximately 1-1/2 cents per ton. When paired with a mechanically unloaded silo, it can feed a herd of 60 cows without any manual labor except that of turning the system on and off.

Mechanical hay and silage conveyor

A dual conveyor system for mechanically feeding stanchioned dairy cows has been developed by the Vermont station. One conveyor brings the feed from the stored supply, the other moves it down the manger in front of the animals. Cows along the line are prevented from reaching for the feed moving along the trough by an electric fence trainer. The trainer swings out of the way when the conveyors stop automatically, which happens when the feed reaches the last cow on the line.

Potato grader-polisher

A portable combination grader-polisher has been developed and constructed with available commercial parts by the Michigan station. Two motors drive the unit--one for the grader, elevator, and sorting table, and one for the polishing rolls, of 1/2 and 3/4 hp., respectively. The unit provides a clean and sized product to the consumer and permits the potato grower to carry out these operations with one piece of equipment, which uses less space and with a lower first investment cost.

New building materials for farm use

New materials for farm building purposes, available locally, have been announced by the Idaho, South Dakota, and Tennessee stations. The product developed in Idaho has both strength and insulating qualities. It includes 5 parts wood wastes such as sawdust or shavings, mixed with 1 part clay, 1 part Portland cement, and 1 part of a naturally occurring material known as diatomite. The South Dakota station developed a process for converting native shale into a light-weight aggregate used in the manufacture of building blocks. The Tennessee station developed a new type, light-weight concrete building block which is laid up with an adhesive rather than sand mortar. It, too, is made of expanded shale aggregate.

Pond water treatment plant

Simple and relatively inexpensive equipment has been developed by the Oklahoma station for a unit-type, water-treating plant which will provide clear pure water from the farm pond for household and Grade A dairy use. In many areas ground water supplies are scarce or highly mineralized, but surface runoff may be stored for future use. This new equipment employs the same processes as are used in municipal filtration plants, but on a smaller scale. The treating process involves flocculation, filtering, and chlorination in such a way that a minimum of attention to the system is required.

STATISTICS--PERSONNEL, PUBLICATIONS, INCOME, AND EXPENDITURES

Personnel and Publications

The research personnel of the Experiment Stations in 1954 included 3,576 staff members devoting full time to station research and 4,360 who divided time between research and teaching or extension work. The total in both categories, 7,936, represented an increase of 459 over the total of 1953.

Printed publications of the experiment stations in 1954 included 789 bulletins, circulars, and reports; 5,502 articles in scientific journals; and 635 miscellaneous publications. In addition, 721 popular and 1,120 technical reports, bulletins, and circulars were processed by the stations.

Data by individual States relating to personnel and publications are shown in tables 1 and 2.

Income and Expenditures

Appropriations under the authorizations of the Hatch, Adams, and Purnell Acts for use by the experiment stations in 1954 totaled $4,590,000, each State, Hawaii, Alaska, and Puerto Rico receiving $90,000. A total of $2,863,708 was appropriated under section 5 of the Bankhead-Jones Act of June 29, 1935, with allotments to the individual States, Hawaii, Alaska, and Puerto Rico as shown in table 3. These allotments are made primarily on the basis of rural population adjusted in accordance with the provisions of the Department of Agriculture Organic Act of 1944. The total amount of Federal-grant funds appropriated to the Office of Experiment Stations under the Hatch, Adams, and Purnell Acts, and title I, section 5, of the Bankhead-Jones Act, was $7,453,708.

Under Title I, section 9, of the Bankhead-Jones Act $6,000,000 was appropriated. Of this total $180,000, authorized by section 9 (c) of the act, was available to the Office of Experiment Stations for administration. Of the remainder $4,320,000 was allotted to the States, Hawaii, Alaska, and Puerto Rico, under the formulas described in sections 9 (b) (1) and (2); $1,500,000 was available for allotment to the States for cooperative regional research projects authorized by section 9 (b) (3) and for travel by the Committee of Nine established in accordance with this section. The amounts allotted under sections 9 (b) (1), (2), and (3) are shown in table 3.

In addition to the Federal-grant funds enumerated above, the Office received funds from the Agricultural Marketing Act, Section 204(b) for allotment to the State agricultural experiment stations for marketing research. Allotments totaling $268,000.00 were made to the stations during the fiscal year 1954 (table 3).

Non-Federal income of the stations appears in table 4.

Expenditures of Federal-grant funds are shown under object classes by individual experiment stations in tables 5, 6, 7, 8, 9, and 10; expenditures of non-Federal funds are indicated in table 11. The 1954 expenditures of non-Federal funds which include State appropriations, research grants, and income from other sources totaled $67,205,204.62, as compared with $61,970,921.10 in 1953. The 1954 non-Federal fund expenditures by all of the stations approximated $5.08 for each $1 of Federal grants. Summaries of expenditures appear in tables 12 and 13.

Expenditures and allotments of funds from the Agricultural Marketing Act are shown in table 14.

TABLE 1.—Organization and personnel of the experiment stations for the year ended June 30, 1954

Station	Date of legislative aaaent to Hatch Act	Date of organization under Hatch Act	Personnel				
			Full-time research	Research and teaching	Research and extension	Research, teaching, and extension	Total research workers
			Number	*Number*	*Number*	*Number*	*Number*
Alabama	Feb. 27, 1889..	Apr. 1, 1888....	61	61	.....	2	124
Alaska	May 2, 1929..	May 1, 1931....	12	3	10	3	28
Arizona	Mar. 19, 1889..	July 1, 1889....	46	44	.....	.....	90
Arkansas	Mar. 7, 1889..	Apr. 2, 1888....	48	54	1	1	104
California	Mar. 12, 1889..	Mar. 13,1888....	148	362	.....	.....	510
Colorado	Mar. 25, 1889..	Feb. 20, 1888...	35	88	.....	5	128
Connecticut:							
State	May 18, 1887..	May 18, 1887...	76	.....	.....	.....	76
Storrs	....do.....	Apr. 1, 1888...	31	36	2	11	80
Delaware	Apr. 14, 1887..	Feb. 21, 1888...	19	19	6	5	49
Florida	June 7, 1887..	Mar. 16, 1888...	184	29	5	4	222
Georgia	Dec. 24, 1888..	Feb. 18, 1888...	136	59	2	13	210
Hawaii	Mar. 31, 1911..	July 1, 1929...	42	18	2	1	63
Idaho	Jan. 23, 1891..	Feb. 26, 1892...	31	42	2	1	76
Illinois	May 11, 1887..	Mar. 21, 1888...	98	123	12	4	237
Indiana	Jan. 19, 1889..	July 1, 1887...	135	92	21	14	262
Iowa	Mar. 1, 1888..	Feb. 17, 1888...	88	132	19	22	261
Kansas	Mar. 3, 1887..	Feb. 8, 1888...	49	183	1	.....	233
Kentucky	Feb. 20, 1888..	Apr. 29, 1888...	114	39	4	10	167
Louisiana	July 12, 1888..	Apr. 5, 1887...	117	60	1	.....	178
Maine	Mar. 16, 1887..	Feb. 16, 1888...	32	38	.....	1	71
Maryland	Mar. 6, 1888..	Mar. 9, 1888...	18	37	7	32	94
Masaachusetts	Apr. 20, 1887..	Mar. 2, 1888...	66	10	1	18	95
Michigan	Apr. 12, 1889..	Feb. 26, 1888...	94	135	9	8	246
Minnesota	Feb. 4, 1889..	Jan. 26, 1888...	9	195	4	5	213
Mississippi	Jan. 31, 1888..	Spring, 1888...	86	57	2	3	148
Miasouri	June 11, 1889..	Jan. 31, 1888...	22	135	2	4	163
Montana	Feb. 16, 1893..	July 1, 1893...	54	58	1	12	125
Nebraska	Mar. 31, 1887..	June 14, 1887...	70	85	.....	1	156
Nevada	Feb. 8, 1889..	Dec., 1887...	15	8	.....	5	28
New Hampahire	Aug. 4, 1887..	Feb. 22, 1888...	17	43	4	8	72
New Jeraey	Mar. 16, 1887..	Mar. 5, 1888...	88	69	2	2	161
New Mexico	Feb. 28, 1889..	Nov. 14, 1889...	37	31	1	4	73
New York:							
Cornell	Mar. 30, 1887..	Apr. 30, 1888...	34	148	15	44	241
State	(1)	.....	75	.....	.....	.....	75
North Carolina	Mar. 7, 1887..	Dec. 5, 1889...	109	118	.....	4	231
North Dakota	Mar. 8, 1890..	Oct. 14, 1890...	44	47	.....	.....	91
Ohio	Mar. 16, 1887..	Apr. 2, 1888...	78	86	2	5	171
Oklahoma	Oct. 27, 1890..	Aug. 14, 1891...	69	109	2	1	181
Oregon	Feb. 25, 1889..	July 2, 1888...	119	105	3	3	230
Pennsylvania	June 3, 1887..	June 30, 1887...	1	214	.....	2	217
Puerto Rico	Aug. 16, 1933..	Nov. 14, 1935...	107	.....	.....	.....	107
Rhode Island	Mar. 31, 1887..	Nov. 3, 1888...	18	19	2	7	46
South Carolina	Dec. 22, 1887..	Jan., 1888...	86	25	2	2	115
South Dakota	Mar. 11, 1887..	Nov. 17, 1887...	32	60	.....	1	93
Tenneaaee	Mar. 29, 1887..	July 24, 1887...	114	48	2	11	175
Texas	Apr. 2, 1887..	Jan. 25, 1888...	207	66	5	16	294
Utah	Mar. 8, 1888..	Nov. 6, 1889...	46	69	.....	6	121
Vermont	Nov., 1888..	Feb. 28, 1888...	8	28	4	16	56
Virginia	Feb. 29, 1888..	June 13, 1888...	103	38	6	11	158
Washington	Mar. 9, 1891..	May 1, 1891...	124	76	.....	3	203
West Virginia	Feb. 22, 1889..	June 11, 1888...	17	71	1	2	91
Wiaconsin	(2)	July 1, 1887...	70	117	9	20	216
Wyoming	Jan. 10, 1891..	Mar. 27, 1891...	37	42	.....	2	81
Total	.....	.....	3,576	3,831	174	355	7,936

[1] First made eligible to receive part of the State allotment of Federal funds by legislative act approved May 12, 1894.
[2] Seaaion of 1887.

TABLE 2.--Publications issued by the agricultural experiment stations during the fiscal year ended June 30, 1954

Station	Printed publications																Processed publications			
	Reports, bulletins, and circulars				Articles in journals				Periodicals				Pamphlets, leaflets, etc.				Reports, bulletins, circulars, etc.			
	Pop.	Tech.	Pages	Copies	Pop.	Tech.	Pages	Copies reprinted	Pop.	Tech.	Pages	Copies	Pop.	Tech.	Pages	Copies	Pop.	Tech.	Pages	Copies
Alabama	1	7	320	40,000	.....	73	376	12,800	1	.....	8	8,000	5	.....	20	37,000	52	21	392	53,750
Alaska	5	6	146	28,500	.....	16	42	700	.....	.....	.....	.....	5	.....	14	12,000	7	10	112	5,200
Arizona	14	2	1,009	37,450	.....	20	100	.....	4	.....	52	50,000	2	.....	20	10,000	.....	1	89	250
Arkansas	1	15	466	56,500	.....	12	45	.....	.....	4	32	350,000	.....	.....	.....	.....	.....	30	200	21,890
California	15	7	928	249,500	282	800	11,795	.....	12	16	743	395,500	22	.....	192	366,000	.....	12	670	4,700
Colorado	8	6	732	93,500	.....	26	284	5,200	2	.....	184	158,400	.....	.....	.....	.....	27	.....	450	16,091
Conneticut:																				
State	10	7	712	87,400	31	99	669	.....	1	.....	8	19,000	.....	.....	.....	.....	5	.....	36	3,500
Storrs	.....	10	380	19,700	.....	50	404	12,800	2	.....	20	16,000	.....	.....	.....	.....	.....	11	102	13,500
Delaware	4	9	306	27,000	.....	29	164	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	4	95	300
Florida	1	38	1,366	359,000	178	154	638	.....	.....	.....	.....	.....	3	.....	24	7,000	.....	65	713	272,260
Georgia	18	2	523	86,762	.....	51	276	.....	1	.....	4	10,000	.....	.....	.....	.....	35	1	263	55,250
Hawaii	7	4	288	17,600	.....	26	212	.....	4	.....	32	10,300	.....	.....	.....	.....	17	.....	149	25,675
Idaho	12	4	256	80,000	7	.....	(1)	(1)	2	.....	16	30,000	.....	.....	.....	.....	.....	.....	.....	.....
Illinois	3	12	671	127,500	.....	196	1,277	.....	.....	4	83	43,100	.....	.....	.....	.....	3	43	586	29,400
Indiana	23	9	1,112	172,500	.....	69	426	.....	.....	.....	.....	.....	.....	.....	.....	.....	137	22	376	254,878
Iowa	1	12	582	73,825	.....	152	1,216	76,000	12	.....	280	293,500	59	.....	228	(1)	.....	1	24	500
Kansas	26	.....	887	124,506	37	199	1,840	.....	.....	.....	.....	.....	1	4	510	16,825	186	36	2,240	761,950
Kentucky	3	11	722	70,800	17	28	166	.....	.....	.....	.....	.....	10	.....	62	70,000	1	4	181	9,418
Louisiana	.....	13	647	49,000	.....	137	449	.....	.....	4	32	16,800	.....	.....	.....	.....	4	75	1,406	37,910
Maine	.....	8	131	11,450	51	37	(1)	.....	4	.....	98	26,300	1	4	156	12,950	.....	8	124	3,500
Maryland	3	1	166	13,500	14	49	366	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21	546	10,500
Massachusetts	.....	12	514	31,700	.....	78	477	17,575	2	12	80	15,100	.....	.....	.....	.....	.....	.....	.....	.....
Michigan	11	5	490	86,000	.....	114	709	.....	4	.....	501	9,600	.....	.....	.....	.....	.....	.....	.....	.....
Minnesota	6	3	476	92,500	.....	113	387	.....	3	.....	56	49,500	8	.....	182	60,000	.....	12	170	11,950
Mississippi	29	3	889	127,000	.....	55	(1)	.....	12	.....	96	480,000	15	.....	30	26,000	3	.....	220	4,000
Missouri	20	18	912	113,300	.....	82	(1)	.....	12	.....	48	330,000	52	.....	52	104,000	.....	.....	.....	.....
Montana	11	2	616	59,000	.....	23	167	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	.....	565	4,000
Nebraska	8	2	321	58,000	.....	36	(1)	.....	4	.....	64	53,000	54	1	184	94,900	29	1	414	35,520
Nevada	4	.....	57	12,000	.....	9	(1)	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Hampshire	.....	8	218	12,500	.....	6	22	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	7	1,000
New Jersey	10	5	374	71,000	.....	47	188	.....	2	12	1,096	99,000	12	.....	131	32,750	10	.....	86	59,300
New Mexico	10	.....	264	27,500	.....	4	14	300	.....	.....	.....	.....	.....	.....	.....	.....	17	.....	181	10,700
New York:																				
Cornell	.....	16	1,217	62,950	.....	731	2,894	.....	4	.....	64	100,000	.....	.....	.....	.....	.....	235	4,652	(1)
State	.....	10	232	45,200	.....	32	(1)	.....	4	.....	64	108,000	2	.....	10	2,000	6	100	329	21,035
North Carolina	11	6	556	145,000	.....	81	250	.....	3	.....	48	18,000	.....	.....	.....	.....	22	28	769	33,385
North Dakota	7	.....	290	43,500	32	40	151	.....	6	.....	248	50,000	1	.....	2	8,000	24	7	166	144,040
Ohio	3	20	888	105,300	.....	55	420	.....	6	.....	96	138,000	33	.....	127	80,800	.....	173	1,187	97,901
Oklahoma	23	4	505	114,000	.....	42	217	(1)	6	.....	118	18,000	7	.....	185	26,750	17	.....	193	(1)
Oregon	9	2	230	54,000	.....	64	(1)	(1)	3	.....	60	20,500	6	.....	12	11,250	18	4	203	42,550
Pennsylvania	18	9	433	94,000	3	58	290	.....	4	.....	64	75,000	.....	.....	.....	.....	.....	3	77	1,300
Puerto Rico	.....	14	653	42,000	.....	6	25	.....	.....	4	245	12,000	8	.....	82	8,000	.....	.....	.....	.....
Rhode Island	4	7	300	17,100	.....	14	56	2,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
South Carolina	.....	13	486	76,000	15	7	(1)	.....	.....	2	16	5,000	69	.....	(1)	(1)	.....	104	(1)	(1)
South Dakota	20	.....	758	164,700	.....	20	100	.....	4	.....	100	24,000	1	.....	10	800	.....	.....	.....	.....
Tennessee	4	3	332	29,000	37	77	648	.....	4	.....	48	12,000	.....	.....	.....	.....	.....	.....	.....	.....
Texas	9	11	568	112,000	.....	228	1,098	.....	.....	.....	.....	.....	19	26	1,204	20,000	55	57	1,032	458,000
Utah	.....	10	263	27,500	.....	33	264	.....	.....	4	88	26,000	.....	4	26	61,000	11	.....	122	3,300
Vermont	1	4	170	10,620	.....	10	54	.....	.....	.....	.....	.....	2	.....	15	7,193	1	.....	31	750
Virginia	4	1	270	45,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	32	2,000
Washington	.....	11	432	27,800	.....	120	1,181	27,975	.....	.....	.....	.....	.....	.....	.....	.....	.....	29	361	41,100
West Virginia	7	2	148	38,000	.....	15	62	6,800	4	.....	40	24,000	.....	.....	.....	.....	5	.....	44	25,000
Wisconsin	5	6	536	127,000	.....	370	(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	1	66	70,500
Wyoming	9	1	354	43,500	.....	5	13	(1)	4	.....	72	33,000	1	.....	8	3,000	14	.....	102	7,500
Total	398	391	27,102	3,940,663	704	4,798	30,432	162,650	136	62	4,904	3,126,600	398	39	3,486	1,078,218	721	1,120	19,763	2,655,253

[1] Total unknown.

TABLE 3.--Federal funds available to the experiment stations for the year ended June 30, 1954

	Federal-grant funds[1]					Contractual Federal funds Agricultural Marketing Act Sec. 204(b)			Total Federal funds available
	Bankhead-Jones, title I				Total				
	Hatch, Adams, and Purnell[2]	Sec. 5	Secs. 9(b)1 and 9(b)2	Sec. 9(b)3		Carryover from 1953	1954 allotment	Total	
Alabama	$90,000	$88,305.89	$133,140.70	$36,110.00	$347,556.59	.....	.....	.....	$347,556.59
Alaska	90,000	4,736,40	26,277.21	.....	121,013.61	.....	.....	.....	121,013.61
Arizona	90,000	16,740.68	37,866.36	28,700.00	173,307.04	.....	.....	.....	173,307.04
Arkansas	90,000	66,187.20	110,495.49	18,425.00	285,107.69	.....	.....	.....	285,107.69
California	90,000	102,716.44	120,045.86	32,450.00	345,212.30	.....	$9,000.00	$9,000.00	354,212.30
Colorado	90,000	25,460.16	50,045.50	52,600.00	218,105.66	.....	.....	.....	218,105.66
Connecticut:									
State	45,000	11,257.19	20,232.11	3,000.00	79,489.30	.....	.....	.....	79,489.30
Storrs	45,000	11,257.19	20,232.12	18,300.00	94,789.31	$79.98	7,235.00	7,314.98	102,104.29
Delaware	90,000	5,970.02	29,068.42	7,500.00	132,538.44	.....	.....	.....	132,538.44
Florida	90,000	48,046.76	65,419.75	14,300.00	217,766.51	1,111.75	14,580.00	15,691.75	233,458.26
Georgia	90,000	98,402.95	137,787.52	73,975.00	400,165.47	.....	17,750.00	17,750.00	417,915.47
Hawaii	90,000	10,463.17	34,924.99	8,000.00	143,388.16	.....	.....	.....	143,388.16
Idaho	90,000	16,866.19	43,581.26	22,100.00	172,547.45	.....	.....	.....	172,547.45
Illinois	90,000	99,478.95	127,294.38	45,245.00	362,018.33	1,975.89	5,000.00	6,975.89	368,994.22
Indiana	90,000	79,141.32	110,293.65	54,275.00	333,709.97	441.04	20,900.00	21,341.04	355,051.01
Iowa	90,000	74,227.20	112,139.73	71,545.00	347,911.93	1,048.57	22,300.00	23,348.57	371,260.50
Kansas	90,000	53,057.23	77,378.69	19,100.00	239,535.92	.....	10,000.00	10,000.00	249,535.92
Kentucky	90,000	93,378.88	137,758.14	11,700.00	332,837.02	.....	.....	.....	332,837.02
Louisiana	90,000	60,813.78	93,776.13	21,125.00	265,714.91	.....	.....	.....	265,714.91
Maine	90,000	22,270.68	44,300.11	24,600.00	181,170.79	.....	7,500.00	7,500.00	188,670.79
Maryland	90,000	36,488.62	55,659.01	19,350.00	201,497.63	.....	11,000.00	11,000.00	212,497.63
Massachusetts	90,000	36,698.19	49,846.19	18,600.00	195,144.38	910.51	4,000.00	4,910.51	200,054.89
Michigan	90,000	93,777.64	120,523.38	24,300.00	328,601.02	3,398.96	41,700.00	45,098.96	373,699.98
Minnesota	90,000	68,128.03	108,940.02	32,465.00	299,533.05	.....	.....	.....	299,533.05
Mississippi	90,000	80,016.75	137,501.50	39,905.00	347,423.25	.....	27,000.00	27,000.00	374,423.25
Missouri	90,000	78,849.57	121,398.40	28,500.00	318,747.97	.....	5,000.00	5,000.00	323,747.97
Montana	90,000	18,004.00	41,506.55	28,300.00	177,810.55	.....	.....	.....	177,810.55
Nebraska	90,000	41,343.56	68,193.52	23,875.00	223,412.08	.....	.....	.....	223,412.08
Nevada	90,000	3,435.49	26,316.54	13,900.00	133,652.03	.....	.....	.....	133,652.03
New Hampshire	90,000	11,363.43	33,222.77	14,900.00	149,486.20	.....	.....	.....	149,486.20
New Jersey	90,000	32,575.43	49,336.09	28,000.00	199,911.52	1,496.84	3,030.00	4,526.84	204,438.36
New Mexico	90,000	17,027.28	41,530.45	26,050.00	174,607.73	.....	.....	.....	174,607.73
New York:									
Cornell	81,000	97,003.93	109,059.50	40,450.00	327,513.43	9.87	8,100.00	8,109.87	335,623.30
State	9,000	10,778.21	12,117.72	14,000.00	45,895.93	.....	.....	.....	45,895.93
North Carolina	90,000	135,186.64	186,720.97	55,240.00	467,147.61	.....	.....	.....	467,147.61
North Dakota	90,000	26,670.28	52,461.15	6,975.00	176,106.43	.....	.....	.....	176,106.43
Ohio	90,000	118,853.05	145,105.03	27,900.00	381,858.08	971.35	5,355.00	6,326.35	388,184.43
Oklahoma	90,000	63,847.68	89,445.82	14,050.00	257,343.50	.....	.....	.....	257,343.50
Oregon	90,000	35,230.21	57,874.99	36,800.00	219,905.20	1,746.03	4,000.00	5,746.03	225,651.23
Pennsylvania	90,000	155,317.78	155,603.14	42,100.00	443,020.92	.....	2,000.00	2,000.00	445,020.92
Puerto Rico	90,000	66,036.41	128,351.41	2,500.00	286,887.82	.....	.....	.....	286,887.82
Rhode Island	90,000	6,257.12	27,783.01	24,600.00	148,640.13	.....	5,000.00	5,000.00	153,640.13
South Carolina	90,000	68,111.24	105,754.52	20,580.00	284,445.76	.....	.....	.....	284,445.76
South Dakota	90,000	26,510.78	51,888.73	21,600.00	189,999.51	.....	2,500.00	2,500.00	192,499.51
Tennessee	90,000	92,293.90	139,936.08	26,375.00	348,604.98	.....	9,000.00	9,000.00	357,604.98
Texas	90,000	150,461.58	186,821.22	66,415.00	493,697.80	2,618.92	7,250.00	9,868.92	503,566.72
Utah	90,000	12,499.09	35,961.17	36,200.00	174,660.26	.....	.....	.....	174,660.26
Vermont	90,000	12,884.06	35,459.86	11,000.00	149,343.92	886.93	1,800.00	2,686.93	152,030.85
Virginia	90,000	88,612.55	119,487.94	28,950.00	327,050.49	.....	3,500.00	3,500.00	330,550.49
Washington	90,000	43,950.86	65,831.98	52,100.00	251,882.84	.....	10,000.00	10,000.00	261,882.84
West Virginia	90,000	65,794.28	86,464.55	31,550.00	273,808.83	.....	2,500.00	2,500.00	276,308.83
Wisconsin	90,000	73,259.15	110,600.09	49,170.00	323,029.24	11,583.25	1,000.00	12,583.25	335,612.49
Wyoming	90,000	7,662.93	31,238.49	23,850.00	152,751.42	.....	.....	.....	152,751.42
Total	4,590,000	2,863,708.00	4,319,999.91	1,493,600.00	13,267,307.91	28,279.89	268,000.00	296,279.89	13,563,587.80

[1] Includes unexpended balances from the previous year as follows:
Hatch--Connecticut, $40.92; Storrs (Conn.), $39.35; New York (State), $0.28; Cornell (New York), $14.55.
Adams--Indiana, $121.83; Maryland, $15.00; Cornell (New York), $5.38; Puerto Rico, $755.61; Rhode Island, $9.68.
Purnell--Connecticut, $85.76; Storrs (Conn.), $410.91; New York (State), $12.33; Cornell (New York), $135.88; Puerto Rico, $373.68.
Bankhead-Jones, title I:
Section 5--Connecticut, $90.82; Storrs (Conn.), $78.97; Indiana, $391.85; New York (State), $0.17; Cornell (New York), $0.78; Puerto Rico, $307.72.
Secs. 9(b)1-2--Connecticut, $28.51; Storrs (Conn.), $4.24; Indiana, $7,217.95; Maryland, $588.15; New York (State), $17.30; Cornell (New York), $348.37; Puerto Rico, $76.58; Rhode Island, $86.61; Vermont, $16.34; Wisconsin, $4,421.25.

[2] Hatch, $15,000 for each State, Alaska, Hawaii, and Puerto Rico. Adams, $15,000 for each State, Alaska, Hawaii, and Puerto Rico. Purnell, $60,000 for each State, Alaska, Hawaii and Puerto Rico.

TABLE 4.--Non-Federal funds available to the experiment stations for the year ended June 30, 1954

Station	State appropriations	Special endowments, industrial fellowships, etc.	Fees	Sales	Miscellaneous	Balance from previous year	Total
Alabama	$753,812.68	$83,363.31	.....	$607,066.38	.....	$273,576.52	$1,717,818.89
Alaska	144,000.00	.....	.....	56,827.31	.....	64,445.63	265,272.94
Arizona	434,047.20	28,540.16	.....	39,324.60	.....	.....	501,911.96
Arkansas	497,028.23	52,783.92	.....	227,030.31	.....	130,769.34	907,611.80
California	6,289,405.36	510,280.78	.....	93,783.26	.....	655,048.90	7,548,518.30
Colorado	443,508.88	313,702.50	.....	151,111.21	$9,400.00	174,393.50	1,092,116.09
Connecticut:							
State	369,371.81	20,300.00	.....	.....	.....	.....	389,671.81
Storrs	370,396.00	173,977.00	.....	.....	.....	62,998.00	607,371.00
Delaware	205,025.00	53,448.17	.....	113,838.15	.....	54,142.23	426,453.55
Florida	2,774,539.95	61,742.80	.....	293,859.34	.....	410,259.88	3,540,401.97
Georgia	1,108,733.00	135,603.90	.....	734,752.08	33,472.00	295,704.24	2,308,265.22
Hawaii	444,677.38	.....	.....	82,238.09	18,348.66	7,849.01	553,113.14
Idaho	496,201.41	33,036.41	.....	142,195.44	.....	179,999.86	851,433.12
Illinois	1,611,342.20	297,780.39	.....	346,591.68	.....	.....	2,255,714.27
Indiana	1,158,756.72	224,686.15	$241,203.16	546,229.73	202,820.23	502,292.73	2,875,988.72
Iowa	1,379,983.91	581,689.55	.....	652,187.97	.....	311,914.37	2,925,775.80
Kansas	966,585.00	119,463.90	.....	273,150.38	.....	239,091.52	1,598,290.80
Kentucky	369,862.00	77,164.52	99,712.99	81,117.07	.....	.....	627,856.58
Louisiana	1,620,434.72	57,590.60	.....	.....	119,242.52	.....	1,797,267.84
Maine	244,243.62	22,582.10	.....	52,000.00	.....	39,365.90	358,191.62
Maryland	459,352.98	85,580.65	.....	137,007.71	.....	111,579.51	793,520.85
Massachusetts	466,527.59	43,559.29	.....	.....	.....	37,956.71	548,043.59
Michigan	1,396,839.90	234,741.40	.....	.....	.....	62,045.61	1,693,626.91
Minnesota	1,639,964.79	296,183.42	9,213.20	509,113.36	.....	.....	2,454,474.77
Mississippi	719,446.07	55,775.10	.....	600,454.27	5,783.38	394,022.53	1,775,481.35
Missouri	309,397.97	58,884.12	43,145.09	215,933.49	.....	457,411.84	1,084,772.51
Montana	473,650.00	21,540.97	.....	341,896.24	.....	215,270.77	1,052,357.98
Nebraska	704,334.43	63,787.19	.....	559,486.41	.....	41,188.64	1,368,796.67
Nevada	50,682.05	2,700.00	.....	.....	.....	49,242.48	102,624.53
New Hampshire	127,092.99	23,514.20	.....	10,468.00	.....	419.85	161,495.04
New Jersey	1,144,323.65	470,565.63	.....	.....	.....	4,161.97	1,619,051.25
New Mexico	295,665.00	5,000.00	.....	54,299.06	150.00	33,607.47	388,721.53
New York:							
Cornell	2,626,132.43	313,911.43	.....	465,163.06	.....	.....	3,405,206.92
State	975,878.38	.....	.....	45,730.34	.....	.....	1,021,608.72
North Carolina	1,388,857.63	71,752.00	.....	.....	253,000.32	.....	1,713,609.95
North Dakota	619,071.32	50,436.49	.....	161,377.03	.....	121,042.42	951,927.26
Ohio	1,980,799.72	97,718.22	.....	261,965.74	.....	318,555.05	2,659,038.73
Oklahoma	1,088,473.00	91,262.31	.....	386,781.66	7,356.65	80,037.37	1,653,910.99
Oregon	1,381,864.33	188,255.53	205,176.64	206,815.13	.....	.....	1,982,111.63
Pennsylvania	1,126,291.17	92,747.37	.....	166,622.34	43,516.30	130,334.77	1,559,511.95
Puerto Rico	1,127,831.00	10,000.00	.....	.....	124,549.85	68,872.79	1,331,253.64
Rhode Island	88,504.00	66,491.53	.....	17,735.99	.....	30,004.94	202,736.46
South Carolina	552,131.63	49,723.24	.....	185,000.00	.....	45,419.59	832,274.46
South Dakota	335,200.00	9,214.30	.....	131,772.92	.....	48,835.94	525,023.16
Tennessee	492,027.63	101,697.58	.....	182,710.71	.....	.....	776,435.92
Texas	1,240,488.00	270,855.54	.....	1,019,263.47	250,464.86	702,279.92	3,483,351.79
Utah	387,500.00	185,150.08	.....	61,971.61	4,888.85	62,169.94	701,680.48
Vermont	114,920.47	.....	.....	2,430.03	18,100.00	27,818.28	163,268.78
Virginia	955,845.12	.....	.....	168,030.47	.....	.....	1,123,875.59
Washington	1,573,333.60	165,631.54	.....	222,678.69	.....	.....	1,961,643.83
West Virginia	226,140.00	8,980.00	.....	222,557.47	270.00	125,823.69	583,771.16
Wisconsin	1,464,774.00	640,103.00	.....	507,937.00	.....	.....	2,612,814.00
Wyoming	312,859.00	9,807.76	.....	95,241.95	.....	57,073.54	474,982.25
Total	49,528,154.92	6,633,306.05	598,451.08	11,433,747.15	1,091,363.62	6,627,027.25	75,912,050.07

TABLE 5.—Expenditures and appropriations under the Hatch Act (Mar. 2, 1887)[1] for the year ended June 30, 1954

Station	Expenditures													Unexpended	Appropriation
	Personal Services	Travel	Transportation of things	Communication service	Rents and utility services	Printing and reproduction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Contributions to retirement	Taxes and assessments	Total expenditures		
Alabama	$13,838.74	$196.09	$86.22	$36.80	$244.43	.....	$20.06	$532.91	$44.75	.....	.....	.....	$15,000.00	.....	$15,000
Alaska	14,548.00	171.34	.....	.....	.....	.....	.....	221.49	59.17	.....	.....	.....	15,000.00	.....	15,000
Arizona	14,263.27	33.77	.....	6.44	.....	.....	.....	33.08	.....	.....	$499.14	$164.30	15,000.00	.....	15,000
Arkansas	11,127.37	169.22	.....	.....	70.00	$2,136.42	82.12	1,065.85	114.84	.....	234.18	.....	15,000.00	.....	15,000
California	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Colorado	13,131.04	721.62	.....	36.47	212.78	141.70	25.02	206.55	.....	.....	524.82	.....	15,000.00	.....	15,000
Connecticut:															
State	1,035.00	.....	.....	.....	.....	6,461.68	.....	.....	.....	.....	.....	.....	7,496.68	$3.32	7,500
Storrs	4,963.91	860.09	.....	.....	.....	.....	105.55	18.95	1,501.83	.....	.....	.....	7,450.33	49.67	7,500
Delaware	6,794.20	784.78	3.60	3,445.15	.....	586.41	13.12	2,731.78	640.96	.....	.....	.....	15,000.00	.....	15,000
Florida	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Georgia	9,695.28	.....	.....	.....	.....	512.47	152.33	2,614.32	2,025.60	.....	.....	.....	15,000.00	.....	15,000
Hawaii	13,834.95	1,165.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Idaho	10,588.72	1,759.02	43.38	39.23	.....	2,266.98	.....	302.67	.....	.....	.....	.....	15,000.00	.....	15,000
Illinois	11,926.56	88.73	11.00	2.83	.....	.....	33.46	937.78	1,455.90	.....	543.74	.....	15,000.00	.....	15,000
Indiana	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Iowa	11,464.71	.....	.....	.....	.....	3,149.06	.....	386.23	.....	.....	.....	.....	15,000.00	.....	15,000
Kansas	12,958.24	879.43	.....	19.84	46.49	.....	146.35	503.55	298.97	.....	.....	147.13	15,000.00	.....	15,000
Kentucky	12,878.76	200.08	.....	217.72	.....	940.00	87.17	151.72	395.00	.....	.....	129.55	15,000.00	.....	15,000
Louisiana	14,271.41	337.21	.....	5.51	3.00	.....	11.12	104.46	267.29	.....	.....	.....	15,000.00	.....	15,000
Maine	14,183.11	235.13	.....	30.70	.....	10.65	6.35	532.56	1.50	.....	.....	.....	15,000.00	.....	15,000
Maryland	10,870.00	1,381.06	4.34	36.97	695.13	353.78	508.34	727.07	423.31	.....	.....	.....	15,000.00	.....	15,000
Massachusetts	8,700.00	525.86	2.01	.....	.....	1,054.25	702.00	541.01	3,474.87	.....	.....	.....	15,000.00	.....	15,000
Michigan	7,500.00	.....	.....	.....	.....	7,500.00	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Minnesota	12,366.39	722.68	.....	75.80	.....	227.44	.....	1,388.02	.....	.....	219.67	.....	15,000.00	.....	15,000
Mississippi	14,542.06	.....	20.13	17.95	81.92	.....	71.49	242.49	23.96	.....	.....	.....	15,000.00	.....	15,000
Missouri	11,245.91	1,320.47	217.39	63.00	233.76	72.90	667.78	1,020.46	158.33	.....	.....	.....	15,000.00	.....	15,000
Montana	14,362.60	405.35	17.39	15.15	.....	.87	72.28	126.36	.....	.....	.....	.....	15,000.00	.....	15,000
Nebraska	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Nevada	12,025.63	409.25	.....	831.80	103.06	.....	48.85	1,472.54	108.87	.....	.....	.....	15,000.00	.....	15,000
New Hampshire	14,264.98	46.05	10.63	.....	.....	.....	56.50	567.75	54.09	.....	.....	.....	15,000.00	.....	15,000
New Jersey	12,026.00	433.30	9.92	80.72	45.00	6.20	71.02	835.96	1,491.88	.....	.....	.....	15,000.00	.....	15,000
New Mexico	13,704.90	.....	16.29	22.80	514.35	.....	272.27	469.39	.....	.....	.....	.....	15,000.00	.....	15,000
New York:															
Cornell	10,200.70	130.55	223.78	.....	351.00	.....	200.00	635.52	1,753.60	.....	.....	.....	13,495.15	4.85	13,500
State	1,203.42	40.38	.....	.....	.....	.....	.....	.....	251.75	.....	.....	.....	1,495.55	4.45	1,500
North Carolina	11,507.60	.....	40.00	20.00	32.51	2,229.92	124.35	745.00	300.62	.....	.....	.....	15,000.00	.....	15,000
North Dakota	14,306.00	.....	.....	5.00	.....	.....	.....	.....	.....	.....	689.00	.....	15,000.00	.....	15,000
Ohio	13,766.00	1,063.45	.....	.....	.....	71.34	14.00	85.21	.....	.....	.....	.....	15,000.00	.....	15,000
Oklahoma	11,753.55	234.55	.....	3.55	.....	.....	106.56	2,785.37	116.42	.....	.....	.....	15,000.00	.....	15,000
Oregon	12,290.48	2,709.52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Pennsylvania	7,807.07	397.49	.....	.....	.....	5,104.59	.....	660.07	1,030.78	.....	.....	.....	15,000.00	.....	15,000
Puerto Rico	13,498.48	311.28	50.00	.....	50.00	34.00	50.77	512.18	133.68	.....	.....	.....	14,640.39	359.61	15,000
Rhode Island	10,558.31	497.86	.....	494.36	.....	1,431.75	400.66	1,495.91	121.15	.....	.....	.....	15,000.00	.....	15,000
South Carolina	14,513.50	46.74	.....	164.43	.....	.....	.....	275.33	.....	.....	.....	.....	15,000.00	.....	15,000
South Dakota	8,389.86	721.58	1.89	.....	.....	3,669.87	237.03	456.82	1,522.95	.....	.....	.....	15,000.00	.....	15,000
Tennessee	14,149.92	.....	.....	.08	.....	850.00	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Texas	10,105.06	3,068.09	.....	137.35	.....	213.83	.....	221.74	1,253.93	.....	.....	.....	15,000.00	.....	15,000
Utah	13,886.47	1,113.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Vermont	12,122.83	78.50	23.85	248.13	.....	717.62	220.07	469.82	1,110.29	.....	.....	8.89	15,000.00	.....	15,000
Virginia	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Washington	14,378.44	139.65	2.14	.....	.....	.....	265.31	156.97	57.49	.....	.....	.....	15,000.00	.....	15,000
West Virginia	9,653.13	400.54	.....	.....	526.25	2,151.14	301.14	1,967.80	.....	.....	.....	.....	15,000.00	.....	15,000
Wisconsin	6,758.34	800.45	3.39	.....	.....	549.56	5.95	6,059.07	823.24	.....	.....	.....	15,000.00	.....	15,000
Wyoming	14,601.00	.....	.....	.....	.....	399.00	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Total	623,561.90	24,599.74	787.35	6,057.78	3,209.68	42,843.43	5,079.02	34,261.76	21,017.02	.....	2,710.55	449.87	764,578.10	421.90	765,000

[1] Extended to Hawaii by act of May 16, 1928; to Alaska by act of Feb. 23, 1929; and to Puerto Rico by act of Mar. 4, 1931.

TABLE 6.—Expenditures and appropriations under the Adams Act (Mar. 16, 1906)[1] for the year ended June 30, 1954

Station	Expenditures												Unexpended	Appropriation
	Personal services	Travel	Transportation of things	Communication services	Rents and utility services	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Contributions to retirement	Taxes and assessments	Total expenditures		
Alabama	$12,619.96	$525.25	$31.77	$41.00	$542.02	$92.50	$1,108.50	$39.00	.....	.....	.....	$15,000.00	.....	$15,000
Alaska	13,792.40	354.73	.....	.....	.....	1.50	36.70	814.67	.....	.....	.....	15,000.00	.....	15,000
Arizona	11,821.35	1,893.52	17.92	65.54	47.90	36.49	576.76	.....	.....	$398.84	$141.68	15,000.00	.....	15,000
Arkansas	12,724.20	169.85	5.51	.....	125.00	62.46	949.21	563.77	.....	400.00	.....	15,000.00	.....	15,000
California	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Coloredo	13,320.47	242.89	1.20	21.20	89.32	168.91	609.11	101.50	.....	445.40	.....	15,000.00	.....	15,000
Connecticut:														
State	7,500.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,500.00	.....	7,500
Storre	7,500.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,500.00	.....	7,500
Deleware	12,933.29	248.54	5.16	.97	.....	132.16	1,335.37	344.51	.....	.....	.....	15,000.00	.....	15,000
Floride	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Georgia	12,978.48	108.95	6.20	.....	.....	104.58	742.44	1,064.35	.....	.....	.....	15,000.00	.....	15,000
Hawaii	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Idaho	13,959.98	37.94	1.75	.....	.....	.....	936.33	64.00	.....	.....	.....	15,000.00	.....	15,000
Illinois	12,940.24	50.39	28.40	8.02	.....	.....	659.94	704.06	.....	608.95	.....	15,000.00	.....	15,000
Indiana	12,460.05	.....	3.43	.....	.....	153.29	2,141.20	.....	.....	.....	.....	14,757.97	$242.03	15,000
Iowa	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Kansas	11,919.94	.....	8.90	13.80	.....	53.19	2,801.25	71.55	.....	.....	131.37	15,000.00	.....	15,000
Kentucky	11,594.55	40.00	.....	2.50	.....	.....	2,236.31	954.94	.....	.....	171.70	15,000.00	.....	15,000
Louisiana	13,643.62	313.48	.....	.95	.....	26.69	755.26	260.00	.....	.....	.....	15,000.00	.....	15,000
Maine	14,541.95	129.87	.....	3.00	.....	1.92	289.14	34.12	.....	.....	.....	15,000.00	.....	15,000
Maryland	12,200.00	25.10	4.46	.....	.....	112.21	2,335.59	322.64	.....	.....	.....	15,000.00	.....	15,000
Massachusetts	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Michigan	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Minnesota	11,545.26	4.60	39.22	20.00	.....	102.06	400.20	2,661.25	.....	227.41	.....	15,000.00	.....	15,000
Mississippi	12,153.15	139.26	1.80	52.60	532.52	492.84	1,188.90	438.93	.....	.....	.....	15,000.00	.....	15,000
Missouri	10,745.35	11.62	258.50	7.95	43.85	207.47	3,689.59	35.67	.....	.....	.....	15,000.00	.....	15,000
Montana	13,962.22	425.76	1.15	2.90	.....	96.15	457.84	53.98	.....	.....	.....	15,000.00	.....	15,000
Nebraska	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Nevada	12,663.56	259.75	.....	109.11	.....	34.50	1,160.07	773.01	.....	.....	.....	15,000.00	.....	15,000
New Hampshire	14,890.67	.....	.....	.....	.....	.....	109.33	.....	.....	.....	.....	15,000.00	.....	15,000
New Jersey	14,085.00	98.84	.....	.....	.....	73.75	665.31	77.10	.....	.....	.....	15,000.00	.....	15,000
New Mexico	13,314.95	.....	18.60	11.80	353.83	245.59	1,003.23	52.00	.....	.....	.....	15,000.00	.....	15,000
New York:														
Cornell	10,133.81	16.45	.....	.....	89.38	15.75	2,050.85	1,159.44	.....	.....	.....	13,465.68	34.32	13,500
State	656.40	.....	.....	.....	.....	.....	97.99	742.92	.....	.....	.....	1,497.31	2.69	1,500
North Caroline	14,401.52	.....	.....	.....	.....	.....	398.33	200.15	.....	.....	.....	15,000.00	.....	15,000
North Dakota	14,276.98	.....	.....	.45	.....	26.49	133.58	.....	.....	562.50	.....	15,000.00	.....	15,000
Ohio	14,061.00	97.20	.....	.....	.....	.....	758.64	83.16	.....	.....	.....	15,000.00	.....	15,000
Oklahoma	12,641.77	131.54	.....	.....	.....	189.22	1,068.67	968.80	.....	.....	.....	15,000.00	.....	15,000
Oregon	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Pennsylvania	12,428.00	.....	2.28	.....	.....	.....	636.22	1,933.50	.....	.....	.....	15,000.00	.....	15,000
Puerto Rico	11,561.16	255.56	.....	.....	.....	296.90	2,214.87	597.72	.....	.....	.....	14,926.21	73.79	15,000
Rhode Island	14,095.64	18.51	.....	.....	.....	401.61	473.44	10.80	.....	.....	.....	15,000.00	.....	15,000
South Carolina	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
South Dakota	12,736.18	27.50	4.51	.90	.....	26.26	1,809.66	394.99	.....	.....	.....	15,000.00	.....	15,000
Tanneesee	14,999.88	.....	.....	.12	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Texes	13,523.67	11.20	.....	26.82	52.11	1,197.20	4.05	184.95	.....	.....	.....	15,000.00	.....	15,000
Utah	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Vermont	12,826.17	55.66	24.62	.....	.....	135.78	375.51	1,576.80	.....	.....	5.46	15,000.00	.....	15,000
Virginie	14,962.95	33.41	.....	.....	.....	.....	3.64	.....	.....	.....	.....	15,000.00	.....	15,000
Weshington	13,652.70	20.95	5.61	2.00	.....	.....	1,208.85	109.89	.....	.....	.....	15,000.00	.....	15,000
Wast Virginia	13,729.50	27.65	.....	.....	.....	.....	903.00	339.85	.....	.....	.....	15,000.00	.....	15,000
Wisconsin	10,700.00	.....	4.36	.....	.....	.....	3,436.78	164.49	.....	.....	.....	14,305.63	694.37	15,000
Wyoming	15,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000.00	.....	15,000
Total	688,192.97	5,775.97	475.35	391.63	1,875.93	4,487.47	41,761.66	17,898.51	.....	2,643.10	450.21	763,952.80	1,047.20	765,000

[1] Extended to Hawaii by act of May 16, 1928, to Puerto Rico by act of Mar. 4, 1931, and to Alaska by act of June 30, 1936.

TABLE 7.--Expenditures and sppropriations under ths Purnell Act (Feb. 24, 1925)[1] for the year ended June 30, 1954

Station	Expenditures													Unex-pended	Appro-pristion
	Personal services	Travel	Trans-portstion	Communi-cation aervice	Rents and utility services	Printing and repro-duction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contrsc-tusl)	Contribu-tions to retirement	Taxes and assessments	Totsl expenditures		
Alsbams	$50,487.05	$1,276.21	$20.95	$158.30	$807.76	$688.20	$572.81	$3,287.62	$2,701.10	.....	.....	.....	$60,000.00	.....	$60,000
Alssks	52,550.59	227.85	.....	.....	101.25	.....	.....	1,332.44	2,648.54	$3,139.33	.....	.....	60,000.00	.....	60,000
Arizons	42,129.03	3,139.06	528.64	191.97	75.00	375.40	600.73	7,056.28	3,934.67	.....	$1,444.40	$524.82	60,000.00	.....	60,000
Arkanssa	49,286.37	1,220.48	.....	.....	435.60	934.18	1,520.74	2,492.33	2,915.46	.....	1,194.84	.....	60,000.00	.....	60,000
Californis	60,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,000.00	.....	60,000
Colorado	43,416.73	2,695.07	25.06	165.83	285.90	.....	392.98	7,015.31	4,370.51	.....	1,632.61	.....	60,000.00	.....	60,000
Connecticut:															
State	22,590.26	261.15	.....	.....	.....	101.94	1,050.14	1,307.91	2,357.33	2,291.44	.....	.....	29,960.17	$39.83	30,000
Storra	25,733.52	1,586.02	.....	.....	.....	32.02	72.91	666.74	1,640.92	.....	.....	.....	29,732.13	267.87	30,000
Delsware	44,089.28	2,924.36	15.69	.....	.....	564.01	334.38	8,973.73	3,098.55	.....	.....	.....	60,000.00	.....	60,000
Florida	60,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,000.00	.....	60,000
Georgia	47,039.32	1,243.09	40.70	.....	230.78	21.39	1,314.23	4,568.76	5,541.73	.....	.....	.....	60,000.00	.....	60,000
Hawaii	59,899.57	.....	.....	.....	.....	.....	44.43	56.00	.....	.....	.....	.....	60,000.00	.....	60,000
Idaho	51,173.15	2,490.75	.....	9.64	.....	.....	87.65	6,116.55	122.26	.....	.....	.....	60,000.00	.....	60,000
Illinois	47,401.80	2,471.67	6.11	4.10	.....	8.63	747.23	3,703.82	3,696.49	.....	1,960.15	.....	60,000.00	.....	60,000
Indiana	54,236.14	1,015.24	.....	19.25	.....	.....	77.88	3,475.06	.....	.....	.....	.....	58,823.57	1,176.43	60,000
Iowa	60,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,000.00	.....	60,000
Kansas	55,126.61	444.55	2.91	53.83	100.73	4.47	857.54	2,154.94	610.68	.....	.....	643.74	60,000.00	.....	60,000
Kentucky	52,368.17	1,893.00	16.65	269.35	.....	.....	57.36	4,494.95	190.00	.....	.....	710.52	60,000.00	.....	60,000
Louisiana	54,732.36	1,261.08	48.42	36.50	208.76	898.27	467.90	1,094.66	1,252.05	.....	.....	.....	60,000.00	.....	60,000
Maine	54,931.51	744.91	16.02	62.05	.....	31.82	314.62	2,081.34	1,817.73	.....	.....	.....	60,000.00	.....	60,000
Maryland	47,256.19	1,784.50	29.68	67.67	96.16	489.23	328.09	8,929.35	909.10	109.91	.....	.....	59,999.88	.12	60,000
Massschussstts	49,120.13	1,051.83	35.51	.....	.....	400.00	506.82	2,713.23	5,977.48	195.00	.....	.....	60,000.00	.....	60,000
Michigan	60,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,000.00	.....	60,000
Minnesota	54,816.43	678.26	12.86	317.88	.....	89.36	461.36	2,275.39	717.59	.....	630.87	.....	60,000.00	.....	60,000
Mississippi	46,037.10	1,213.89	158.74	210.57	1,014.34	1,429.36	948.40	5,946.89	3,040.71	.....	.....	.....	60,000.00	.....	60,000
Missouri	50,528.33	448.46	187.40	2.30	370.46	.....	1,105.22	7,326.52	18.31	13.00	.....	.....	60,000.00	.....	60,000
Montana	53,158.59	864.84	13.07	31.49	10.48	3,304.09	755.07	1,537.07	325.30	.....	.....	.....	60,000.00	.....	60,000
Nebraska	59,905.38	.....	.....	.....	.....	.....	.....	94.62	.....	.....	.....	.....	60,000.00	.....	60,000
Nevsds	42,504.54	983.95	161.65	264.54	597.06	235.51	1,545.60	11,184.92	2,522.23	.....	.....	.....	60,000.00	.....	60,000
New Hampshire	56,044.20	85.10	102.69	4.00	.....	.....	777.11	2,577.03	409.87	.....	.....	.....	60,000.00	.....	60,000
New Jersey	51,352.35	665.96	6.57	21.35	1.77	.....	156.67	5,487.54	2,307.79	.....	.....	.....	60,000.00	.....	60,000
New Mexico	50,450.80	1,770.50	16.33	46.21	1,721.23	.....	1,132.13	3,932.19	927.51	.....	.....	.....	59,996.90	3.10	60,000
New York:															
Cornell	40,577.95	915.00	48.65	9.65	952.41	3,119.84	5,327.33	3,014.75	.....	.....	.....	.....	53,965.58	34.42	54,000
State	5,123.25	.....	46.18	.....	.....	.....	113.91	62.30	652.50	.....	.....	.....	5,998.14	1.86	6,000
North Carolina	53,048.00	1,500.99	.....	221.25	.....	.....	418.32	3,700.69	1,110.75	.....	.....	.....	60,000.00	.....	60,000
North Dakots	54,838.16	434.97	34.87	95.66	59.34	726.18	640.15	682.77	308.65	.....	2,179.25	.....	60,000.00	.....	60,000
Ohio	55,174.45	1,775.29	28.79	.....	.....	4.00	270.28	2,578.20	168.99	.....	.....	.....	60,000.00	.....	60,000
Oklahoma	45,229.24	640.57	.....	13.30	49.82	.....	944.59	12,898.25	224.23	.....	.....	.....	60,000.00	.....	60,000
Oregon	58,683.53	390.57	.....	78.55	.....	.....	209.75	254.05	383.55	.....	.....	.....	60,000.00	.....	60,000
Pennsylvanis	48,480.06	780.04	110.88	.....	.....	262.20	306.50	9,905.36	154.96	.....	.....	.....	60,000.00	.....	60,000
Puerto Rico	48,049.18	3,908.69	3.68	6.00	49.58	2,321.57	471.06	3,118.22	1,575.89	.....	.....	.....	59,503.87	496.13	60,000
Rhode Island	53,855.71	545.51	.....	.....	7.00	4.00	12.83	5,432.75	142.20	.....	.....	.....	60,000.00	.....	60,000
South Carolins	56,094.79	1,151.24	.....	80.01	.....	1,070.17	705.82	558.49	339.48	.....	.....	.....	60,000.00	.....	60,000
South Dakota	47,593.74	1,255.64	188.92	206.49	.....	125.05	588.48	7,734.06	2,307.62	.....	.....	.....	60,000.00	.....	60,000
Tennessee	56,734.19	181.12	14.13	4.13	80.93	.....	22.66	663.25	2,299.59	.....	.....	.....	60,000.00	.....	60,000
Texas	46,140.74	1,013.58	64.20	122.74	197.50	625.83	5,842.27	3,803.94	2,138.10	51.10	.....	.....	60,000.00	.....	60,000
Utah	59,113.72	519.83	.....	.....	7.01	.....	18.50	340.94	.....	.....	.....	.....	60,000.00	.....	60,000
Vermont	49,937.12	1,469.04	15.21	9.66	299.31	1,268.12	303.66	4,038.93	2,605.71	.....	.....	53.24	60,000.00	.....	60,000
Virginia	58,492.13	304.23	.....	75.00	.....	.....	245.15	382.69	500.80	.....	.....	.....	60,000.00	.....	60,000
Washington	54,987.04	1,660.36	225.50	24.67	13.00	184.92	328.89	1,786.54	789.08	.....	.....	.....	60,000.00	.....	60,000
West Virginis	52,080.76	1,064.34	3.00	.....	43.96	.....	330.40	3,390.22	3,087.32	.....	.....	.....	60,000.00	.....	60,000
Wisconsin	58,371.06	185.80	.....	.....	.....	.....	.....	175.20	.....	.....	.....	.....	58,732.06	1,267.94	60,000
Wyoming	60,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,000.00	.....	60,000
Total	2,670,970.32	54,138.59	2,229.66	2,883.94	7,817.14	19,319.76	33,330.55	176,404.79	72,843.33	5,799.78	9,042.12	1,932.32	3,056,712.30	3,287.70	3,060,000

[1] Extended to Hswsii by act of May 16, 1928, to Alsska by act of Feb. 23, 1929, and to Puerto Rico by act of Mar. 4, 1931.

TABLE 8.—Expenditures and appropriations under the Bankhead-Jones Act, Title I, sec. 5 for the year ended June 30, 1954

Station	Expenditures													Unexpended	Appropriation
	Personal services	Travel	Transportation of things	Communication service	Rents and utility services	Printing and reproduction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Contributions to retirement	Taxes and assessments	Total expenditures		
Alabama	$74,655.44	$3,570.00	$83.25	$101.25	$688.44	.....	$470.72	$5,998.99	$2,737.80	.....	.....	.....	$88,305.89	.....	$88,305.89
Alaska	4,736.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,736.40	.....	4,736.40
Arizona	11,862.57	1,741.19	245.49	90.83	.....	.....	160.36	769.12	1,295.79	.....	$398.29	$177.04	16,740.68	.....	16,740.68
Arkansas	58,628.41	1,315.57	.....	.....	374.06	$770.65	1,044.57	940.26	1,629.59	.....	1,484.09	.....	66,187.20	.....	66,187.20
California	102,716.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	102,716.44	.....	102,716.44
Colorado	20,380.23	859.32	3.00	25.15	197.74	5.15	761.85	2,455.07	91.26	.....	681.39	.....	25,460.16	.....	25,460.16
Connecticut:															
State	8,040.00	87.47	.....	.....	.....	87.07	659.28	1,024.34	1,336.37	.....	.....	.....	11,234.53	$22.66	11,257.19
Storrs	7,974.00	.....	.....	.....	.....	.....	.....	2,757.02	463.27	.....	.....	.....	11,194.29	62.90	11,257.19
Delaware	5,155.08	309.02	.95	.....	.....	28.00	20.43	406.54	50.00	.....	.....	.....	5,970.02	.....	5,970.02
Florida	45,105.50	229.16	15.07	.....	.....	.....	7.75	2,677.92	.....	.....	.....	.....	48,035.40	11.36	48,046.76
Georgia	81,541.86	2,081.93	33.08	.....	285.08	.....	1,451.34	8,364.51	4,645.15	.....	.....	.....	98,402.95	.....	98,402.95
Hawaii	10,463.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,463.17	.....	10,463.17
Idaho	13,751.56	628.93	2.00	3.20	18.40	.....	12.05	2,450.05	.....	.....	.....	.....	16,866.19	.....	16,866.19
Illinois	83,537.25	1,049.14	55.20	14.23	.....	.....	347.08	6,267.28	4,256.14	.....	3,952.63	.....	99,478.95	.....	99,478.95
Indiana	71,869.08	319.82	3.12	.....	.....	.....	15.00	5,480.59	320.00	.....	.....	.....	78,007.61	1,133.71	79,141.32
Iowa	74,225.20	.....	.....	.....	.....	.....	.....	2.00	.....	.....	.....	.....	74,227.20	.....	74,227.20
Kansas	43,271.98	377.65	.....	5.66	1.10	304.41	949.92	6,436.41	1,172.13	.....	.....	537.97	53,057.23	.....	53,057.23
Kentucky	86,515.91	519.26	22.49	37.31	.....	499.36	221.03	4,323.96	179.59	.....	.....	1,059.97	93,378.88	.....	93,378.88
Louisiana	50,553.26	2,259.23	15.65	186.35	.....	925.06	226.78	2,776.23	3,871.22	.....	.....	.....	60,813.78	.....	60,813.78
Maine	20,035.61	640.91	.....	17.50	7.80	.....	8.80	300.89	1,259.17	.....	.....	.....	22,270.68	.....	22,270.68
Maryland	26,636.38	471.28	127.58	90.49	67.75	37.10	401.95	7,515.40	1,140.69	.....	.....	.....	36,488.62	.....	36,488.62
Massachusetts	24,755.11	398.18	36.21	.....	.....	250.00	381.22	2,990.97	7,691.50	$195.00	.....	.....	36,698.19	.....	36,698.19
Michigan	93,777.64	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	93,777.64	.....	93,777.64
Minnesota	51,287.89	3,140.21	224.84	136.73	101.40	144.64	1,298.34	5,470.20	5,794.14	.....	529.64	.....	68,128.03	.....	68,128.03
Mississippi	67,292.10	940.48	55.98	161.93	1,421.03	139.06	1,474.71	5,199.90	3,331.56	.....	.....	.....	80,016.75	.....	80,016.75
Missouri	65,233.02	963.52	55.50	65.30	402.30	129.70	1,104.05	10,667.32	228.86	.....	.....	.....	78,849.57	.....	78,849.57
Montana	16,465.67	51.10	.....	.....	.....	5.70	372.15	1,039.38	70.00	.....	.....	.....	18,004.00	.....	18,004.00
Nebraska	41,016.32	43.35	.....	.....	.....	.....	135.00	148.89	.....	.....	.....	.....	14,343.56	.....	41,343.56
Nevada	2,708.02	.....	62.34	.....	75.00	55.79	471.04	63.30	.....	.....	.....	.....	3,435.49	.....	3,435.49
New Hampshire	10,968.43	80.55	6.30	.....	.....	.....	.....	242.69	65.46	.....	.....	.....	11,363.43	.....	11,363.43
New Jersey	24,167.41	864.55	.....	22.32	192.00	17.00	175.67	3,723.28	3,413.20	.....	.....	.....	32,575.43	.....	32,575.43
New Mexico	14,964.56	.....	2.44	16.31	.....	.....	357.41	1,630.11	56.45	.....	.....	.....	17,027.28	.....	17,027.28
New York:															
Cornell	63,280.94	4,503.19	35.39	11.05	182.26	3,833.94	16,234.78	8,921.84	.....	.....	.....	.....	97,003.39	.54	97,003.93
State	10,604.40	.....	.....	.....	.....	.....	24.64	96.53	49.41	.....	.....	.....	10,774.98	3.23	10,778.21
North Carolina	120,663.05	2,469.93	80.00	346.39	56.79	54.91	1,316.45	6,533.00	3,666.12	.....	.....	.....	135,186.64	.....	135,186.64
North Dakota	25,318.53	154.49	.....	7.37	.....	.....	19.00	267.89	.....	.....	903.00	.....	26,670.28	.....	26,670.28
Ohio	110,004.67	3,509.85	46.46	.....	.....	233.66	68.82	4,103.39	886.20	.....	.....	.....	118,853.05	.....	118,853.05
Oklahoma	44,129.81	1,320.48	.....	.....	42.35	.....	2,677.13	12,619.79	3,058.12	.....	.....	.....	63,847.68	.....	63,847.68
Oregon	34,012.77	208.39	5.78	22.50	.....	.....	220.05	482.27	278.45	.....	.....	.....	35,230.21	.....	35,230.21
Pennsylvania	129,680.58	861.42	60.58	.....	.....	1,209.75	350.28	19,661.02	3,494.15	.....	.....	.....	155,317.78	.....	155,317.78
Puerto Rico	41,797.53	376.06	66.80	.....	199.79	.....	635.84	20,206.74	2,313.08	.....	.....	.....	65,595.84	440.57	66,036.41
Rhode Island	6,014.97	.....	.....	.....	.....	.....	.....	.....	242.15	.....	.....	.....	6,257.12	.....	6,257.12
South Carolina	63,891.93	272.01	10.07	82.71	64.10	.....	428.51	1,457.27	1,904.64	.....	.....	.....	68,111.24	.....	68,111.24
South Dakota	19,994.05	136.03	12.04	.....	.....	7.28	42.68	5,530.01	788.69	.....	.....	.....	26,510.78	.....	26,510.78
Tennessee	82,989.43	752.93	49.91	.28	23.86	.....	324.01	5,316.43	2,837.05	.....	.....	.....	92,293.90	.....	92,293.90
Texas	119,996.81	2,901.29	40.24	384.06	707.49	85.71	10,785.37	10,248.17	4,994.53	317.91	.....	.....	150,461.58	.....	150,461.58
Utah	12,493.09	6.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,499.09	.....	12,499.09
Vermont	10,886.55	240.78	4.92	57.02	119.64	.....	107.79	1,016.54	428.62	.....	.....	22.20	12,884.06	.....	12,884.06
Virginia	87,068.94	305.58	8.40	27.45	2.00	.....	86.43	582.17	531.58	.....	.....	.....	88,612.55	.....	88,612.55
Washington	38,516.45	598.99	17.50	12.04	.....	9.00	359.19	2,856.20	1,581.49	.....	.....	.....	43,950.86	.....	43,950.86
West Virginia	57,798.57	1,888.85	4.55	.....	4.53	893.72	219.40	4,133.04	851.62	.....	.....	.....	65,794.28	.....	65,794.28
Wisconsin	53,082.11	999.57	79.60	2.50	27.00	.....	988.50	8,818.71	2,882.68	.....	.....	.....	66,880.67	6,378.48	73,259.15
Wyoming	7,497.00	165.93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,662.93	.....	7,662.93
Total	2,454,013.68	44,613.59	1,572.73	1,927.93	5,261.91	9,726.66	47,417.37	204,973.63	75,887.92	512.91	7,949.04	1,797.18	2,855,654.55	8,053.45	2,863,708.00

TABLE 9.—Expenditures and funds available under the Bankhead-Jones Act, title I, secs. 9(b)1 and 9(b)2, for the year ended June 30, 1954

Station	Expenditures													Unexpended	Appropriation
	Personal services	Travel	Transportation of things	Communication service	Rente and utility services	Printing and reproduction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Contributions to retirement	Taxes and assessments	Total expenditures		
Alabama	$98,139.59	$7,316.39	$58.20	$758.31	$2,906.29	$1,768.00	$946.13	$11,149.67	$10,098.12	.....	.....	.....	$133,140.70	.....	$133,140.70
Alaska	24,096.67	283.90	.....	.....	.....	.....	56.00	1,359.20	481.44	.....	.....	.....	26,277.21	.....	26,277.21
Arizona	26,352.15	3,091.87	1,066.64	153.96	724.10	27.80	586.90	3,208.32	1,663.06	.....	$685.46	$306.10	37,866.36	.....	37,866.36
Arkansas	81,962.19	3,042.21	241.80	.....	1,553.91	1,288.66	1,724.94	6,029.77	13,588.26	.....	1,063.75	.....	110,495.49	.....	110,495.49
California	120,045.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	120,045.86	.....	120,045.86
Colorado	38,800.06	2,009.91	64.91	143.50	175.29	26.95	1,054.81	2,930.92	3,293.81	.....	1,545.34	.....	50,045.50	.....	50,045.50
Connecticut:															
State	8,943.30	241.21	.....	.....	.....	1,180.86	451.91	1,297.04	8,041.86	.....	.....	.....	20,156.18	$75.93	20,232.11
Storrs	16,944.28	523.61	.....	.....	.....	.....	57.78	838.02	1,590.74	.....	.....	.....	19,954.43	277.69	20,232.12
Delaware	22,089.17	2,602.65	8.44	2.20	45.00	660.60	416.38	969.82	2,274.16	.....	.....	.....	29,068.42	.....	29,068.42
Florida	57,940.08	1,108.46	.....	.....	420.11	.....	.....	767.39	4,382.09	.....	.....	.....	64,618.13	801.62	65,419.75
Georgia	119,173.65	2,903.13	32.26	22.75	268.46	.....	479.30	8,719.70	6,072.02	$116.25	.....	.....	137,787.52	.....	137,787.52
Hawaii	28,553.28	715.75	58.69	.....	.....	1,197.25	150.81	951.24	2,328.32	.....	.....	.....	33,955.34	969.65	34,924.99
Idaho	33,894.64	2,676.11	99.98	12.91	10.00	.....	8.00	6,351.64	527.98	.....	.....	.....	43,581.26	.....	43,581.26
Illinois	83,015.35	1,829.86	42.67	15.02	77.04	961.14	4,322.96	20,685.12	13,164.21	.....	2,830.70	.....	126,944.07	350.31	127,294.38
Indiana	87,788.13	322.79	6.07	3.25	180.00	.....	2,278.94	12,988.22	3,802.75	.....	.....	.....	107,370.15	2,923.50	110,293.65
Iowa	112,139.73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	112,139.73	.....	112,139.73
Kansas	68,721.16	1,026.32	21.12	57.03	33.50	302.68	536.62	4,584.17	1,207.58	.....	.....	888.51	77,378.69	.....	77,378.69
Kentucky	104,617.49	5,674.50	32.18	108.38	25.00	2,662.93	1,100.66	17,853.74	4,371.05	.....	.....	1,312.21	137,758.14	.....	137,758.14
Louisiana	70,365.31	3,620.96	23.47	178.24	343.27	605.79	1,244.29	6,100.59	10,833.44	460.77	.....	.....	93,776.13	.....	93,776.13
Maine	38,410.11	3,852.73	23.31	154.26	68.20	54.69	153.78	1,152.28	430.75	.....	.....	.....	44,300.11	.....	44,300.11
Maryland	36,117.11	2,094.15	.....	81.88	128.77	79.52	1,949.43	9,170.43	5,933.31	104.41	.....	.....	55,659.01	.....	55,659.01
Massachusetts	26,306.59	1,898.06	66.06	253.82	.....	2,102.30	655.25	9,692.49	8,871.62	.....	.....	.....	49,846.19	.....	49,846.19
Michigan	120,191.09	302.06	.....	.....	.....	.....	.....	.....	30.23	.....	.....	.....	120,523.38	.....	120,523.38
Minnesota	80,451.74	4,590.58	362.25	417.62	57.63	692.58	2,431.46	10,448.03	9,488.13	.....	.....	.....	108,940.02	.....	108,940.02
Mississippi	104,886.28	3,543.07	139.35	507.73	1,280.51	2,414.50	1,801.05	14,207.43	8,721.58	.....	.....	.....	137,501.50	.....	137,501.50
Missouri	101,864.54	2,908.60	494.77	113.27	427.14	5.75	4,176.70	10,959.79	447.84	.....	.....	.....	121,398.40	.....	121,398.40
Montana	36,807.72	267.78	6.88	10.75	.....	6.30	1,661.15	1,801.42	944.55	.....	.....	.....	41,506.55	.....	41,506.55
Nebraska	63,114.58	753.15	102.00	.80	.....	.....	1,937.70	316.69	1,968.60	.....	.....	.....	68,193.52	.....	68,193.52
Nevada	19,354.09	230.41	37.03	331.18	333.59	.....	742.04	4,673.43	614.77	.....	.....	.....	26,316.54	.....	26,316.54
New Hampshire	32,664.76	4.26	.....	.....	.....	.....	.....	299.53	254.22	.....	.....	.....	33,222.77	.....	33,222.77
New Jersey	40,342.91	996.78	59.23	112.00	249.77	.....	1,755.15	3,009.28	2,810.97	.....	.....	.....	49,336.09	.....	49,336.09
New Mexico	33,189.68	293.15	34.56	48.58	520.85	.....	883.45	6,125.02	435.16	.....	.....	.....	41,530.45	.....	41,530.45
New York:															
Cornell	59,629.98	6,890.27	312.27	273.11	540.31	271.98	5,585.23	15,605.70	19,949.12	.....	.....	.....	109,057.97	1.53	109,059.50
State	6,082.87	102.80	.....	47.60	.....	.....	675.85	1,965.75	3,226.78	.....	.....	.....	12,101.65	16.07	12,117.72
North Carolina	161,567.79	2,142.88	14.05	479.89	121.13	136.46	1,388.77	9,956.08	5,913.92	5,000.00	.....	.....	186,720.97	.....	186,720.97
North Dakota	43,163.07	1,651.75	10.03	54.31	604.64	500.00	349.25	3,618.65	1,077.00	.....	1,432.45	.....	52,461.15	.....	52,461.15
Ohio	131,456.88	5,709.45	37.57	.20	100.00	304.42	1,292.94	4,451.17	1,752.40	.....	.....	.....	145,105.03	.....	145,105.03
Oklahoma	72,911.66	1,508.90	.....	.....	595.84	.....	1,315.74	11,273.33	1,840.35	.....	.....	.....	89,445.82	.....	89,445.82
Oregon	53,832.10	926.83	.....	33.84	8.39	.....	571.84	1,509.15	992.84	.....	.....	.....	57,874.99	.....	57,874.99
Pennsylvania	101,622.44	1,452.26	152.31	169.23	.....	962.20	289.22	19,367.04	25,173.87	6,414.57	.....	.....	155,603.14	.....	155,603.14
Puerto Rico	88,366.59	2,814.41	66.80	6.00	522.12	1,231.58	601.06	24,524.40	4,499.46	5,480.00	.....	.....	128,112.42	238.99	128,351.41
Rhode Island	25,189.34	304.65	.....	.....	811.90	241.74	27.10	1,208.28	.....	.....	.....	.....	27,783.01	.....	27,783.01
South Carolina	91,749.98	2,524.66	95.72	436.62	912.16	1,332.97	1,365.34	5,909.78	1,427.29	.....	.....	.....	105,754.52	.....	105,754.52
South Dakota	39,890.64	437.81	15.83	152.25	36.00	2,139.59	189.61	7,898.78	1,128.22	.....	.....	.....	51,888.73	.....	51,888.73
Tennessee	112,901.54	4,042.12	159.44	82.94	10.46	29.15	2,156.16	9,466.42	9,459.85	1,628.00	.....	.....	139,936.08	.....	139,936.08
Texas	130,173.79	9,774.21	191.57	985.56	949.52	133.12	21,602.75	11,365.99	11,494.59	150.12	.....	.....	186,821.22	.....	186,821.22
Utah	24,221.84	1,411.99	30.53	50.00	369.40	.....	389.82	7,751.94	1,735.65	.....	.....	.....	35,961.17	.....	35,961.17
Vermont	29,023.49	895.79	22.28	61.09	84.34	54.72	355.69	1,748.50	3,178.14	.....	.....	35.82	35,459.86	.....	35,459.86
Virginia	98,992.79	3,081.80	57.10	98.00	.....	103.59	2,299.78	8,706.91	6,147.97	.....	.....	.....	119,487.94	.....	119,487.94
Washington	46,397.24	1,237.15	228.33	5.84	.....	44.30	500.10	8,547.09	2,371.93	6,500.00	.....	.....	65,831.98	.....	65,831.98
West Virginia	72,351.70	5,163.80	4.53	14.70	152.78	692.52	169.61	5,724.33	2,190.58	.....	.....	.....	86,464.55	.....	86,464.55
Wisconsin	64,321.29	1,068.75	138.12	7.59	159.51	93.35	1,613.41	28,701.85	4,927.51	.....	.....	.....	101,031.38	9,568.71	110,600.09
Wyoming	30,566.01	2,299.78	138.92	417.53	500.00	.....	583.83	2,152.91	4,579.51	.....	.....	.....	31,238.49	.....	31,238.49
Total	3,411,096.32	116,166.47	4,757.27	6,863.74	16,306.93	24,309.99	76,886.69	370,094.44	241,739.60	25,854.12	7,557.70	2,542.64	4,304,775.91	15,224.00	4,319,999.91

TABLE 10.--Expenditures and funds available under the Bankhead-Jones Act, Title I, Sec. 9(b)3, for the year andad June 30, 1954

Station	Expenditures													Unexpended	Funds available
	Personal services	Travel	Transportation of things	Communication service	Rents and utility services	Printing and reproduction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Contributions to retirement	Taxes and assessments	Total expenditures		
Alabama	$23,244.29	$2,711.67	$2.74	$31.88	$2.95	$903.17	$226.58	$3,894.27	$5,092.45	.....	.....	.....	$36,110.00	.....	$36,110.00
Alaska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	21,671.14	1,141.18	307.20	424.91	103.02	140.52	1,343.94	2,227.66	300.00	.....	$702.40	$338.03	28,700.00	.....	28,700.00
Arkansas	18,140.00	43.85	.....	.....	.....	.....	.....	56.15	.....	.....	185.00	.....	18,425.00	.....	18,425.00
California	25,578.21	4,008.37	.....	.95	.....	525.00	439.73	1,296.14	601.60	.....	.....	.....	32,450.00	.....	32,450.00
Colorado	23,653.03	10,528.25	53.02	827.89	462.80	1,326.15	1,141.77	6,691.19	7,363.77	$18.24	421.43	.....	52,487.54	$112.46	52,600.00
Connecticut:															
State	3,000.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,000.00	.....	3,000.00
Storrs	14,219.64	1,092.80	.....	.....	75.00	.....	.....	734.35	1,934.77	.....	.....	.....	18,056.56	243.44	18,300.00
Delaware	3,011.92	133.61	3.57	.....	.....	.....	529.31	2,180.35	1,641.24	.....	.....	.....	7,500.00	.....	7,500.00
Florida	10,692.24	1,568.68	13.35	.....	292.30	.....	4.00	1,484.05	.....	.....	.....	.....	14,054.62	245.38	14,300.00
Georgia	35,834.36	9,964.88	113.04	9.91	172.42	.....	1,532.09	3,967.24	8,567.49	13,813.57	.....	.....	73,975.00	.....	73,975.00
Hawaii	6,419.66	1,133.01	.....	48.00	.....	81.00	28.23	43.24	.....	.....	.....	.....	7,753.14	246.86	8,000.00
Idaho	16,966.76	1,036.29	.....	.40	.....	.....	.....	4,096.55	.....	.....	.....	.....	22,100.00	.....	22,100.00
Illinois	33,155.21	3,609.91	92.14	57.90	.....	75.00	639.67	3,478.52	1,018.09	.....	764.58	.....	42,891.02	2,353.98	45,245.00
Indiana	23,712.90	1,245.91	410.21	69.44	837.80	.....	2,497.62	17,390.44	4,269.92	2,549.47	.....	.....	52,983.71	1,291.29	54,275.00
Iowa	36,532.28	5,950.98	262.87	355.67	.....	10.40	10,100.52	17,074.05	1,258.23	.....	.....	.....	71,545.00	.....	71,545.00
Kansas	9,138.13	2,227.20	6.78	48.73	133.90	.....	1,107.70	4,917.20	1,447.91	.....	.....	70.68	19,098.23	1.77	19,100.00
Kentucky	6,718.16	975.89	.....	25.73	.....	.....	34.64	2,302.83	1,642.75	.....	.....	.....	11,700.00	.....	11,700.00
Louisiana	13,762.64	2,346.46	30.83	66.75	170.89	191.80	929.83	1,196.89	2,428.91	.....	.....	.....	21,125.00	.....	21,125.00
Maine	21,062.41	1,634.10	75.80	127.56	.....	.....	278.74	1,367.48	53.91	.....	.....	.....	24,600.00	.....	24,600.00
Maryland	10,436.59	1,355.31	30.76	72.92	82.96	434.15	574.39	4,958.71	841.59	.....	.....	.....	18,787.38	562.62	19,350.00
Massachusetts	9,889.71	837.77	38.89	.....	.....	500.00	2,080.00	2,948.90	2,218.06	.....	.....	.....	18,513.33	86.67	18,600.00
Michigan	17,872.21	2,333.56	26.11	7.10	.....	.....	846.99	1,441.26	1,772.77	.....	.....	.....	24,300.00	.....	24,300.00
Minnesota	18,542.56	1,854.21	36.65	48.40	20.00	7,146.30	1,108.93	2,925.30	782.65	.....	.....	.....	32,465.00	.....	32,465.00
Mississippi	30,631.26	3,415.33	82.17	348.63	188.37	1,459.05	742.91	3,022.28	15.00	.....	.....	.....	39,905.00	.....	39,905.00
Missouri	20,418.01	2,513.33	6.02	10.15	144.76	.....	213.85	1,923.81	1,656.00	1,614.07	.....	.....	28,500.00	.....	28,500.00
Montana	18,057.51	3,050.40	54.57	104.65	17.50	109.39	3,185.37	1,020.28	1,061.39	19.23	.....	.....	26,680.29	1,619.71	28,300.00
Nebraska	21,358.19	1,935.17	2.47	.....	.....	14.34	.....	400.08	164.75	.....	.....	.....	23,875.00	.....	23,875.00
Nevada	8,100.28	2,880.86	.....	5.00	.....	.....	1.25	1,379.61	1,533.00	.....	.....	.....	13,900.00	.....	13,900.00
New Hampshire	5,859.60	1,094.70	21.71	35.12	.....	5.60	1,911.21	4,367.89	1,604.17	.....	.....	.....	14,900.00	.....	14,900.00
New Jersey	17,380.04	3,562.38	.....	7.90	.....	1,605.73	1,045.61	1,638.44	2,525.26	.....	.....	.....	27,765.36	234.64	28,000.00
New Mexico	18,005.44	1,962.27	34.61	49.36	546.96	.....	164.13	3,070.09	2,217.14	.....	.....	.....	26,050.00	.....	26,050.00
New York:															
Cornell	20,142.15	3,715.29	191.07	298.69	78.82	1,550.00	827.49	5,190.68	8,171.73	.....	.....	.....	40,165.92	284.08	40,450.00
State	5,938.90	528.72	35.05	100.00	20.00	.....	712.59	1,878.80	4,737.44	.....	.....	.....	13,951.50	48.50	14,000.00
North Carolina	34,661.82	8,546.25	.....	133.80	2,300.80	2,890.41	1,141.14	3,677.32	1,888.46	.....	.....	.....	55,240.00	.....	55,240.00
North Dakota	5,503.77	49.12	13.70	2.98	57.18	326.36	65.56	299.08	580.25	.....	77.00	.....	6,975.00	.....	6,975.00
Ohio	22,903.40	4,237.10	.....	.....	.....	77.31	97.19	205.00	380.00	.....	.....	.....	27,900.00	.....	27,900.00
Oklahoma	9,172.75	2,702.07	.....	.....	.....	.....	164.70	1,721.88	288.60	.....	.....	.....	14,050.00	.....	14,050.00
Oregon	31,710.27	406.83	.....	3.29	1.00	.....	593.83	1,560.38	2,084.23	440.17	.....	.....	36,800.00	.....	36,800.00
Pennsylvania	26,230.92	1,681.14	36.60	62.60	.....	.....	4,297.17	3,265.77	6,525.80	.....	.....	.....	42,100.00	.....	42,100.00
Puerto Rico	1,908.45	.....	.....	.....	.....	.....	.....	367.15	80.00	.....	.....	.....	2,355.60	144.40	2,500.00
Rhode Island	22,515.69	810.84	.....	.....	.....	22.48	459.94	791.05	.....	.....	.....	.....	24,600.00	.....	24,600.00
South Carolina	17,547.96	243.75	.....	95.29	.....	.....	128.44	2,564.56	.....	.....	.....	.....	20,580.00	.....	20,580.00
South Dakota	15,252.70	417.36	1.93	.....	69.82	126.85	138.13	1,975.59	3,617.62	.....	.....	.....	21,600.00	.....	21,600.00
Tannessee	25,343.19	280.41	.....	2.50	.....	.....	43.05	705.85	.....	.....	.....	.....	26,375.00	.....	26,375.00
Texas	50,964.67	5,019.47	43.07	324.89	273.50	26.00	2,599.16	5,837.21	1,327.03	.....	.....	.....	66,415.00	.....	66,415.00
Utah	25,654.61	3,557.01	32.16	66.70	937.33	272.00	603.42	4,458.78	617.99	.....	.....	.....	36,200.00	.....	36,200.00
Vermont	8,560.51	748.96	.....	.....	42.56	.....	16.74	844.24	750.17	.....	.....	7.96	10,971.14	28.86	11,000.00
Virginia	15,601.57	1,358.95	.....	3.00	81.35	4,321.79	5,438.00	1,338.43	806.91	.....	.....	.....	28,950.00	.....	28,950.00
Washington	35,163.33	6,199.82	58.76	98.50	246.25	27.50	1,819.13	4,125.30	2,836.71	.....	.....	.....	50,575.30	1,524.70	52,100.00
West Virginia	19,420.67	2,464.80	3.00	.....	.....	915.00	335.10	1,862.18	4,999.17	.....	.....	.....	29,999.92	1,550.08	31,550.00
Wisconsin	22,508.32	5,617.90	118.15	.18	896.44	623.96	1,590.71	12,381.58	4,524.41	.....	.....	.....	48,261.65	908.35	49,170.00
Wyoming	12,762.50	3,978.63	27.96	190.55	.....	.....	193.57	2,368.79	4,328.00	.....	.....	.....	23,850.00	.....	23,850.00
Total	972,532.53	130,712.75	2,266.96	4,167.92	8,256.68	25,707.26	53,974.07	160,914.87	102,557.34	18,454.75	2,150.41	416.67	1,482,112.21	11,487.79	1,493,600.00

TABLE 11.--Expenditurea from non-Federal funds for the year ended June 30, 1954

Station	Personal services	Travel	Transportation of things	Communication service	Renta and utility services	Printing and reproduction	Other contractual services	Suppliea and materiala	Equipment	Lands and structurea (contractual)	Contributions to retirement	Taxes and aasessments[1]	Total	Unexpended balances
Alabama	$727,222.08	$35,651.90	$7,236.12	$7,911.10	$28,557.01	$4,239.68	$93,655.51	$358,750.96	$127,099.31	$25,802.04	$6,857.69	.....	$1,422,983.40	$294,835.49
Alaska	112,677.19	1,229.94	1,188.06	217.61	665.81	1,355.27	13,732.85	22,853.29	3,928.32	34,823.88	.....	$2,462.55	195,134.77	70,138.17
Arizona	345,865.93	12,810.99	5,919.74	4,177.80	8,649.67	8,951.27	12,188.27	42,373.31	53,669.59	4,515.82	942.21	1,847.36	501,911.96	.....
Arkansas	430,017.60	32,715.65	3,643.52	5,952.69	21,204.32	6,049.40	30,965.64	141,409.50	46,322.63	14,082.62	5,062.80	5,684.32	743,110.69	164,501.11
California	5,287,099.50	259,753.60	9,948.98	74,809.05	66,348.00	76,958.05	191,577.70	410,484.60	328,506.15	.....	.....	.....	6,705,485.63	843,032.67
Colorado	444,736.02	17,221.90	2,045.97	5,313.72	27,735.86	472.74	116,284.02	139,479.42	51,102.18	39,131.53	11,433.12	.....	854,956.48	237,159.61
Connecticut:														
State	319,564.39	2,041.83	331.83	3,039.16	9,237.19	2,993.31	13,667.71	25,683.47	4,403.19	.....	.....	.....	380,962.08	8,709.73
Storrs	389,058.00	6,892.00	216.00	472.00	2,645.00	5,630.00	4,419.00	58,447.00	30,723.00	49,000.00	.....	.....	547,502.00	59,869.00
Delaware	203,091.30	6,083.37	2,384.72	1,304.31	7,231.56	2,900.14	16,754.98	90,165.98	21,144.05	3,098.75	.....	.....	354,159.16	72,294.39
Florida	2,217,977.98	88,658.63	5,839.65	17,724.53	57,890.17	27,276.33	51,862.36	396,824.45	124,350.81	20,960.49	.....	[1] 318.21	3,009,683.61	530,718.36
Georgia	937,096.94	32,133.78	1,370.41	12,918.69	41,098.29	13,949.56	59,543.70	535,812.65	117,214.56	145,542.39	2,238.94	28,190.21	1,927,110.12	381,155.10
Hawaii	387,939.90	5,269.34	1,370.22	3,214.58	7,584.13	5,431.19	25,394.62	67,786.63	31,305.01	7,376.59	.....	.....	542,672.21	10,440.93
Idaho	375,138.42	15,713.37	5,800.00	10,500.00	12,800.00	2,500.00	5,000.00	129,160.61	69,724.00	103,200.00	.....	100.00	729,636.40	121,796.72
Illinois	1,634,378.41	90,000.00	.....	30,000.00	.....	70,000.00	45,000.00	338,869.43	47,404.15	62.28	.....	.....	2,255,714.27	.....
Indiana	1,287,428.61	45,009.09	10,596.32	15,752.92	25,529.41	83,843.92	156,712.35	568,109.58	132,990.92	184,599.90	.....	.....	2,510,573.02	365,415.70
Iowa	1,061,032.71	88,897.57	4,848.31	11,077.81	.....	20,519.02	2,851.49	803,506.79	162,176.97	121,779.82	75,716.22	.....	2,352,406.71	573,369.09
Kansas	929,054.61	20,458.23	10,819.11	9,763.11	24,658.21	15,064.34	41,363.59	184,136.40	130,491.98	610.31	.....	2,543.82	1,368,963.71	229,327.09
Kentucky	427,794.33	18,680.55	2,934.14	4,700.14	12,777.13	18,414.63	27,085.12	87,753.21	22,523.12	.....	5,194.21	.....	627,856.58	.....
Louisiana	1,026,678.17	49,314.60	3,461.75	16,466.93	30,363.51	6,760.42	121,394.25	311,997.48	94,333.97	136,496.76	.....	.....	1,797,267.84	.....
Maine	206,675.91	17,071.74	1,889.91	2,550.64	10,152.72	7,093.66	15,939.35	50,470.92	14,759.57	1,420.00	.....	.....	328,024.42	30,167.20
Maryland	444,718.94	14,577.07	655.59	2,109.13	5,847.88	3,401.86	26,314.50	153,072.45	39,401.43	8,226.29	.....	.....	698,325.14	95,195.71
Massachusetta	443,626.96	8,458.83	2,167.44	5,336.15	2,226.11	3,366.35	6,724.76	27,022.40	7,555.08	.....	.....	.....	506,484.08	41,559.51
Michigan	1,190,438.53	46,873.67	1,812.77	3,995.86	11,533.43	19,992.77	66,155.71	142,805.57	77,411.91	.....	.....	.....	1,561,020.22	132,606.69
Minnesota	1,612,025.33	32,257.09	8,047.69	15,309.90	34,579.66	8,551.96	199,151.53	409,151.42	118,644.61	16,755.58	.....	.....	2,454,474.77	.....
Misaiaaippi	731,735.63	19,569.48	7,745.27	8,057.84	48,276.85	14,556.67	61,841.94	344,944.37	116,071.33	27,715.62	38,281.31	.....	1,418,796.31	356,685.04
Missouri	454,831.66	35,759.34	2,924.55	5,782.67	10,173.99	26,574.37	36,494.81	140,187.18	45,567.97	38,960.33	9,555.42	.....	806,812.29	277,960.22
Montana	510,651.72	11,824.96	3,178.06	5,421.03	37,064.15	6,048.17	17,572.97	182,576.01	29,897.94	21,854.52	18,814.89	.....	844,904.42	207,453.56
Nebraaka	722,609.44	31,439.36	7,435.75	6,491.27	12,270.74	22,542.44	7,816.52	403,310.87	100,200.13	2,341.19	.....	1,259.32	1,317,717.03	51,079.64
Nevada	46,491.86	2,943.44	36.16	688.05	1,994.42	283.48	5,001.50	19,006.03	8,860.03	.....	.....	.....	85,304.97	17,319.56
New Hampshire	81,828.98	5,196.86	847.10	936.26	956.40	2,448.63	750.96	56,936.49	10,940.20	.....	.....	.....	160,841.88	653.16
New Jeraey	1,128,204.37	35,473.17	3,475.64	20,168.15	42,856.95	16,010.08	108,818.44	188,335.52	68,092.08	.....	.....	.....	1,611,434.40	7,616.85
New Mexico	264,346.76	5,123.66	919.08	1,538.61	8,757.53	3,483.71	9,748.97	38,029.56	26,195.89	9,271.11	9,329.32	.....	376,744.20	11,977.33
New York:														
Cornell	2,243,431.00	39,207.80	8,244.38	26,088.50	160,630.60	17,314.86	145,029.95	331,720.12	94,368.14	24,339.55	.....	920.59	3,091,295.49	313,911.43
State	835,540.50	10,532.03	1,899.51	4,928.64	14,335.13	14,716.34	12,524.53	99,212.38	27,589.66	330.00	.....	.....	1,021,608.72	.....
North Carolina	1,258,613.87	33,108.84	2,968.56	15,774.03	17,953.43	17,889.16	91,847.36	169,617.08	87,105.96	18,731.66	.....	.....	1,713,609.95	.....
North Dakota	383,926.69	12,966.55	5,603.75	3,304.61	31,572.47	9,353.64	36,972.48	125,151.26	50,219.52	132,246.49	8,766.76	.....	800,084.22	151,843.04
Ohio	1,083,136.64	27,627.66	8,785.39	10,374.46	25,486.31	6,909.71	30,732.06	314,623.61	51,424.45	241,662.55	.....	.....	1,800,762.84	858,275.89
Oklahoma	700,546.67	28,400.69	2,815.37	4,136.13	27,736.00	13,225.88	80,085.02	296,887.37	54,127.36	112,528.22	5,158.99	.....	1,325,647.70	328,263.29
Oregon	1,300,743.78	68,547.82	7,550.25	11,982.82	19,586.70	16,839.02	46,560.80	298,468.77	112,042.23	29,521.00	43,372.83	26,895.61	1,982,111.63	.....
Pennaylvania	934,241.72	35,232.87	957.83	2,790.03	5,855.72	23,337.20	3,189.73	204,925.49	44,752.44	11,269.98	.....	.....	1,266,553.01	292,958.94
Puerto Rico	672,070.65	16,556.78	1,322.58	6,024.28	21,620.78	18,247.16	14,629.56	120,114.84	91,084.09	49,518.63	31,973.00	14,523.84	1,057,686.19	273,567.45
Rhode Ialand	107,028.28	1,497.40	155.99	1,015.80	1,426.51	1,216.47	1,855.58	46,595.08	3,087.52	336.11	.....	.....	164,214.74	38,521.72
South Carolina	505,445.06	13,270.88	2,789.78	3,728.83	13,985.18	6,479.47	39,058.87	146,473.65	47,223.21	.....	.....	.....	778,454.93	53,819.53
South Dakota	276,345.59	13,548.85	1,719.21	2,182.98	1,450.83	10,754.65	9,192.62	97,103.94	43,021.96	.....	.....	.....	455,320.63	69,702.53
Tennessee	449,492.42	21,010.55	5,201.26	7,694.86	10,808.70	6,862.26	27,957.20	158,217.34	89,191.33	.....	.....	.....	776,435.92	.....
Texaa	1,595,017.82	53,976.05	4,814.32	22,675.00	75,383.05	3,420.43	247,781.72	332,877.99	233,483.97	93,127.00	19,087.20	67,417.64	2,749,062.19	734,289.60
Utah	358,064.03	22,846.79	1,139.02	2,966.79	13,968.69	9,135.93	16,241.95	103,395.88	33,396.91	5,588.20	9,544.79	.....	576,288.98	125,391.50
Vermont	69,978.36	5,334.80	49.55	1,636.92	5,537.91	1,289.31	17,371.69	5,212.03	6,843.21	742.23	5,161.90	2,490.78	121,648.69	41,620.09
Virginia	687,274.72	28,285.58	3,309.08	10,644.94	31,196.57	3,160.89	53,214.91	159,380.11	77,150.76	21,802.72	.....	.....	1,075,420.28	48,455.31
Waahington	1,324,199.31	51,069.61	11,012.80	10,651.72	21,213.17	16,248.39	58,223.39	333,994.63	77,307.13	1,576.75	56,146.93	.....	1,961,643.83	.....
Weat Virginia	205,674.30	3,332.43	505.41	3,586.03	16,059.09	520.85	34,883.78	139,885.55	37,225.25	.....	.....	.....	441,672.69	142,098.47
Wiaconain	2,014,067.00	25,415.00	2,935.00	2,568.00	12,865.00	11,821.00	55,760.00	416,103.00	71,280.00	.....	.....	.....	2,612,814.00	.....
Wyoming	253,598.01	26,171.53	.....	6,154.73	11,384.87	6,311.22	14,353.00	82,791.33	33,128.53	.....	.....	.....	433,893.22	41,089.03
Total	43,640,474.60	1,633,045.52	194,868.90	474,611.81	1,151,722.81	722,717.26	2,629,251.32	10,852,205.00	3,628,065.71	1,760,948.91	362,638.53	154,654.25	67,205,204.62	8,706,845.45

[1] Includea $318.21 in Refunds, Awarda and Indemnitiea.

TABLE 12.--Summary by States of expenditures of the experiment stations for the year ended June 30, 1954

Station	Federal-grant funds							Contractual Federal funds, Agricultural Marketing Act, Sec. 204(b)	Non-Federal funds	Grand total
	Hatch	Adams	Purnell	Bankhead-Jones, title I			Total			
				Sec. 5	Secs. 9(b)1 & 9(b)2	Sec. 9(b)3				
Alabama	$15,000.00	$15,000.00	$60,000.00	$88,305.89	$133,140.70	$36,110.00	$347,556.59	.....	$1,422,983.40	$1,770,539.99
Alaska	15,000.00	15,000.00	60,000.00	4,736.40	26,277.21	.....	121,013.61	.....	195,134.77	316,148.38
Arizona	15,000.00	15,000.00	60,000.00	16,740.68	37,866.36	28,700.00	173,307.04	.....	501,911.96	675,219.00
Arkansas	15,000.00	15,000.00	60,000.00	66,187.20	110,495.49	18,425.00	285,107.69	.....	743,110.69	1,028,218.38
California	15,000.00	15,000.00	60,000.00	102,716.44	120,045.86	32,450.00	345,212.30	$9,000.00	6,705,485.63	7,059,697.93
Colorado	15,000.00	15,000.00	60,000.00	25,460.16	50,045.50	52,487.54	217,993.20	.....	854,956.48	1,072,949.68
Connecticut:										
State	7,496.68	7,500.00	29,960.17	11,234.53	20,156.18	3,000.00	79,347.56	.....	380,962.08	460,309.64
Storrs	7,450.33	7,500.00	29,732.13	11,194.29	19,954.43	18,056.56	93,887.74	5,684.42	547,502.00	647,074.16
Delaware	15,000.00	15,000.00	60,000.00	5,970.02	29,068.42	7,500.00	132,538.44	.....	354,159.16	486,697.60
Florida	15,000.00	15,000.00	60,000.00	48,035.40	64,618.13	14,054.62	216,708.15	13,098.87	3,009,683.61	3,239,490.63
Georgia	15,000.00	15,000.00	60,000.00	98,402.95	137,787.52	73,975.00	400,165.47	17,527.29	1,927,110.12	2,344,802.88
Hawaii	15,000.00	15,000.00	60,000.00	10,463.17	33,955.34	7,753.14	142,171.65	.....	542,672.21	684,843.86
Idaho	15,000.00	15,000.00	60,000.00	16,866.19	43,581.26	22,100.00	172,547.45	.....	729,636.40	902,183.85
Illinois	15,000.00	15,000.00	60,000.00	99,478.95	126,944.07	42,891.02	359,314.04	4,926.59	2,255,714.27	2,619,954.90
Indiana	15,000.00	14,757.97	58,823.57	78,007.61	107,370.15	52,983.71	326,943.01	19,620.67	2,510,573.02	2,857,136.70
Iowa	15,000.00	15,000.00	60,000.00	74,227.20	112,139.73	71,545.00	347,911.93	23,264.96	2,352,406.71	2,723,583.60
Kansas	15,000.00	15,000.00	60,000.00	53,057.23	77,378.69	19,098.23	239,534.15	9,999.54	1,368,963.71	1,618,497.40
Kentucky	15,000.00	15,000.00	60,000.00	93,378.88	137,758.14	11,700.00	332,837.02	.....	627,856.58	960,693.60
Louisiana	15,000.00	15,000.00	60,000.00	60,813.78	93,776.13	21,125.00	265,714.91	.....	1,797,267.84	2,062,982.75
Maine	15,000.00	15,000.00	60,000.00	22,270.68	44,300.11	24,600.00	181,170.79	7,500.00	328,024.42	516,695.21
Maryland	15,000.00	15,000.00	59,999.88	36,488.62	55,659.01	18,787.38	200,934.89	10,984.18	698,325.14	910,244.21
Massachusetts	15,000.00	15,000.00	60,000.00	36,698.19	49,846.19	18,513.33	195,057.71	3,820.70	506,484.08	705,362.49
Michigan	15,000.00	15,000.00	60,000.00	93,777.64	120,523.38	24,300.00	328,601.02	43,089.95	1,561,020.22	1,932,711.19
Minnesota	15,000.00	15,000.00	60,000.00	68,128.03	108,940.02	32,465.00	299,533.05	.....	2,454,474.77	2,754,007.82
Mississippi	15,000.00	15,000.00	60,000.00	80,016.75	137,501.50	39,905.00	347,423.25	27,000.00	1,418,796.31	1,793,219.56
Missouri	15,000.00	15,000.00	60,000.00	78,849.57	121,398.40	28,500.00	318,747.97	5,000.00	806,812.29	1,130,560.26
Montana	15,000.00	15,000.00	60,000.00	18,004.00	41,506.55	26,680.29	176,190.84	.....	844,904.42	1,021,095.26
Nebraska	15,000.00	15,000.00	60,000.00	41,343.56	68,193.52	23,875.00	223,412.08	.....	1,317,717.03	1,541,129.11
Nevada	15,000.00	15,000.00	60,000.00	3,435.49	26,316.54	13,900.00	133,652.03	.....	85,304.97	218,957.00
New Hampshire	15,000.00	15,000.00	60,000.00	11,363.43	33,222.77	14,900.00	149,486.20	.....	160,841.88	310,328.08
New Jersey	15,000.00	15,000.00	60,000.00	32,575.43	49,336.09	27,765.36	199,676.88	4,525.81	1,611,434.40	1,815,637.09
New Mexico	15,000.00	15,000.00	59,996.90	17,027.28	41,530.45	26,050.00	174,604.63	.....	376,744.20	551,348.83
New York:										
Cornell	13,495.15	13,465.68	53,965.58	97,003.39	109,057.97	40,165.92	327,153.69	5,333.06	3,091,295.49	3,423,782.24
State	1,495.55	1,497.31	5,998.14	10,774.98	12,101.65	13,951.50	45,819.13	.....	1,021,608.72	1,067,427.85
North Carolina	15,000.00	15,000.00	60,000.00	135,186.64	186,720.97	55,240.00	467,147.61	.....	1,713,609.95	2,180,757.56
North Dakota	15,000.00	15,000.00	60,000.00	26,670.28	52,461.15	6,975.00	176,106.43	.....	800,084.22	976,190.65
Ohio	15,000.00	15,000.00	60,000.00	118,853.05	145,105.03	27,900.00	381,858.08	6,313.34	1,800,762.84	2,188,934.26
Oklahoma	15,000.00	15,000.00	60,000.00	63,847.68	89,445.82	14,050.00	257,343.50	.....	1,325,647.70	1,582,991.20
Oregon	15,000.00	15,000.00	60,000.00	35,230.21	57,874.99	36,800.00	219,905.20	5,746.03	1,982,111.63	2,207,762.86
Pennsylvania	15,000.00	15,000.00	60,000.00	155,317.78	155,603.14	42,100.00	443,020.92	705.40	1,266,553.01	1,710,279.33
Puerto Rico	14,640.39	14,926.21	59,503.87	65,595.84	128,112.42	2,355.60	285,134.33	.....	1,057,686.19	1,342,820.52
Rhode Island	15,000.00	15,000.00	60,000.00	6,257.12	27,783.01	24,600.00	148,640.13	4,536.51	164,214.74	317,391.38
South Carolina	15,000.00	15,000.00	60,000.00	68,111.24	105,754.52	20,580.00	284,445.76	.. ..	778,454.93	1,062,900.69
South Dakota	15,000.00	15,000.00	60,000.00	26,510.78	51,888.73	21,600.00	189,999.51	2,500.00	455,320.63	647,820.14
Tennassaa	15,000.00	15,000.00	60,000.00	92,293.90	139,936.08	26,375.00	348,604.98	8,628.04	776,435.92	1,133,668.94
Texas	15,000.00	15,000.00	60,000.00	150,461.58	186,821.22	66,415.00	493,697.80	8,618.92	2,749,062.19	3,251,378.91
Utah	15,000.00	15,000.00	60,000.00	12,499.09	35,961.17	36,200.00	174,660.26	.....	576,288.98	750,949.24
Vermont	15,000.00	15,000.00	60,000.00	12,884.06	35,459.86	10,971.14	149,315.06	2,277.71	121,648.69	273,241.46
Virginia	15,000.00	15,000.00	60,000.00	88,612.55	119,487.94	28,950.00	327,050.49	2,027.35	1,075,420.28	1,404,498.12
Washington	15,000.00	15,000.00	60,000.00	43,950.86	65,831.98	50,575.30	250,358.14	9,027.29	1,961,643.83	2,221,029.26
West Virginia	15,000.00	15,000.00	60,000.00	65,794.28	86,464.55	29,999.92	272,258.75	2,500.00	441,672.69	716,431.44
Wisconsin	15,000.00	14,305.63	58,732.06	66,880.67	101,031.38	48,261.65	304,211.39	10,157.83	2,612,814.00	2,927,183.22
Wyoming	15,000.00	15,000.00	60,000.00	7,662.93	31,238.49	23,850.00	152,751.42	.....	433,893.22	586,644.64
Total	764,578.10	763,952.80	3,056,712.30	2,855,654.55	4,304,775.91	1,482,112.21	13,227,785.87	273,414.46	67,205,204.62	80,706,404.95

TABLE 13.--Summary by classification of expenditurss of the experiment stations for the year ended June 30, 1954

Account	Hatch Act	Adams Act	Purnell Act	Bankhead-Jones Act, title I			Total	Contractual Federal funds, Agricultural Marketing Act, Sec. 204(b)	Non-Federal funds	Grand total
				Sec. 5	Secs. 9(b)1 and 9(b)2	Sec. 9(b)3				
01 Personal services	$623,561.90	$688,192.97	$2,670,970.32	$2,454,013.68	$3,411,696.32	$972,532.53	$10,820,967.72	$205,243.68	$43,640,474.60	$54,666,686.00
02 Travel	24,599.74	5,775.97	54,138.59	44,613.59	116,166.47	130,712.75	376,007.11	19,273.27	1,633,045.52	2,028,325.90
03 Transportation of things	787.35	475.35	2,229.66	1,572.73	4,757.27	2,266.96	12,089.32	598.55	194,868.90	207,556.77
04 Communication service	6,057.78	391.63	2,883.94	1,927.93	6,863.74	4,167.92	22,292.94	1,143.09	474,611.81	498,047.84
05 Rents and utility services	3,209.68	1,875.93	7,817.14	5,261.91	16,306.93	8,256.68	42,728.27	1,629.72	1,151,722.81	1,196,080.80
06 Printing and reproduction	42,843.43	.....	19,319.76	9,726.66	24,309.99	25,707.26	121,907.10	1,409.53	722,717.26	846,033.89
07 Other contractual services	5,079.02	4,487.47	33,330.55	47,417.37	76,886.69	53,974.07	221,175.17	11,294.78	2,629,251.32	2,861,721.27
08 Supplies and materials	34,261.76	41,761.66	176,404.79	204,973.63	370,094.44	160,914.87	988,411.15	17,821.61	10,852,205.00	11,858,437.76
09 Equipment	21,017.02	17,898.51	72,843.33	75,887.92	241,739.60	102,557.34	531,943.72	14,393.91	3,628,065.71	4,174,403.34
10 Lands and structures (contractual)	.....	.....	5,799.78	512.91	25,854.12	18,454.75	50,621.56	460.03	1,760,948.91	1,812,030.50
11 Contributions to retirement	2,710.55	2,643.10	9,042.12	7,949.04	7,557.70	2,150.41	32,052.92	.....	362,638.53	394,691.45
13 Refunds, awards, and indemnities	.....	.....	.....	.....	.....	.....	.....	.....	318.21	318.21
15 Taxes and assessments	449.87	450.21	1,932.32	1,797.18	2,542.64	416.67	7,588.89	146.29	154,336.04	162,071.22
Total	764,578.10	763,952.80	3,056,712.30	2,855,654.55	4,304,775.91	1,482,112.21	13,227,785.87	273,414.46	67,205,204.62	80,706,404.95

TABLE 14.—Expenditures and allotments under the Agricultural Marketing Act, Section 204(b), for the year ended June 30, 1954

Station	Expenditures												Unexpended	Funds available[1]
	Personal services	Travel	Transportation of things	Communication service	Rents and utility services	Printing and reproduction	Other contractual services	Supplies and materials	Equipment	Lands and structures (contractual)	Taxes and assessments	Total expenditures		
California	$7,394.62	$440.85	.....	$28.13	.....	.....	.....	$1,136.40	.....	.....	.....	$9,000.00	.....	$9,000.00
Connecticut (Storrs)	4,676.40	487.59	.....	.....	.....	.....	$240.00	138.28	$142.15	.....	.....	5,684.42	$1,630.56	7,314.98
Florida	12,935.67	.....	.....	.....	.....	.....	96.00	.....	67.20	.....	.....	13,098.87	1,592.88	14,691.75
Georgia	12,983.65	2,434.56	$2.02	.....	.....	.....	122.43	1,238.28	746.35	.....	.....	17,527.29	222.71	17,750.00
Illinois	4,425.00	368.90	.....	14.92	.....	.....	.....	54.63	63.14	.....	.....	4,926.59	2,049.30	6,975.89
Indiana	13,958.27	813.18	13.62	.....	.....	.....	294.90	1,540.82	2,999.88	.....	.....	19,620.67	1,720.37	21,341.04
Iowa	18,777.54	1,095.76	57.94	557.59	.....	$79.75	.....	2,273.92	422.46	.....	.....	23,264.96	83.61	23,348.57
Kansas	9,392.70	109.85	.....	.....	.....	.....	53.32	.....	300.00	.....	$143.67	9,999.54	.46	10,000.00
Maine	4,522.51	758.69	203.44	87.70	$430.00	.....	705.25	792.41	.....	.....	.....	7,500.00	.....	7,500.00
Maryland	7,274.64	3,432.75	.....	.....	.....	200.00	40.00	36.79	.....	.....	.....	10,984.18	15.82	11,000.00
Massachusetts	3,463.64	238.08	.....	55.81	.....	.....	.....	58.17	5.00	.....	.....	3,820.70	1,089.81	4,910.51
Michigan	32,606.69	1,018.26	18.74	71.51	.....	639.79	5,953.05	608.70	2,173.21	.....	.....	43,089.95	2,009.01	45,098.96
Mississippi	18,560.60	1,405.59	229.46	209.13	1,199.72	159.18	380.71	1,838.11	3,017.50	.....	.....	27,000.00	.....	27,000.00
Missouri	3,834.46	744.18	.....	6.15	.....	.....	75.43	240.48	99.30	.....	.....	5,000.00	.....	5,000.00
New Jersey	2,145.22	90.55	.....	.....	.....	.....	133.91	660.00	1,036.10	$460.03	.....	4,525.81	1.03	4,526.84
New York (Cornell)	1,353.64	678.75	32.78	11.05	.....	.....	.....	1,789.59	1,467.25	.....	.....	5,333.06	3,776.81	9,109.87
Ohio	4,764.23	1,107.23	.....	.....	.....	.....	.....	441.88	.....	.....	.....	6,313.34	13.01	6,326.35
Oregon	5,263.85	391.13	.....	31.01	.....	.....	.....	.84	59.20	.....	.....	5,746.03	.....	5,746.03
Pennsylvania	375.00	230.63	.....	.....	.....	.....	.....	99.77	.....	.....	.....	705.40	1,294.60	2,000.00
Rhode Island	3,551.43	136.85	.....	.....	.....	.....	756.00	.....	92.23	.....	.....	4,536.51	463.49	5,000.00
South Dakota	2,349.87	144.05	.....	.....	.....	.....	.....	6.08	.....	.....	.....	2,500.00	.....	2,500.00
Tennessee	6,564.73	108.76	.....	4.54	.....	.....	1.50	1,699.81	248.70	.....	.....	8,628.04	371.96	9,000.00
Texas	5,864.42	108.06	.....	.....	.....	307.40	1,641.45	629.74	67.85	.....	.....	8,618.92	1,250.00	9,868.92
Vermont	1,967.78	152.13	.....	19.00	.....	.....	60.00	72.68	3.50	.....	2.62	2,277.71	409.22	2,686.93
Virginia	1,685.86	191.49	.....	.....	.....	.....	150.00	.....	.....	.....	.....	2,027.35	1,472.65	3,500.00
Washington	8,113.63	735.31	6.49	46.55	.....	23.41	54.40	.....	47.50	.....	.....	9,027.29	972.71	10,000.00
West Virginia	1,315.28	1,167.91	.....	.....	.....	.....	.....	16.81	.....	.....	.....	2,500.00	.....	2,500.00
Wisconsin	5,122.35	682.18	34.06	.....	.....	.....	536.43	2,447.42	1,335.39	.....	.....	10,157.83	2,425.42	12,583.25
Total	205,243.68	19,273.27	598.55	1,143.09	1,629.72	1,409.53	11,294.78	17,821.61	14,393.91	460.03	146.29	273,414.46	22,865.43	296,279.89

[1] Included are allotments from the appropriation for fiscal year 1954 plus unexpended balances of allotments from appropriation for fiscal year 1953.

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